H. MOHN.

NORDHAVETS DYBDER, TEMPERATUR OG STRØMNINGER.

THE NORTH OCEAN,

ITS DEPTHS, TEMPERATURE AND CIRCULATION.

DEN NORSKE NORDHAVS-EXPEDITION

1876—1878.

NORDHAVETS

Dybder, Temperatur og Strømninger

VED

H. MOHN.

MED 48 PLADER OG KARTER SAMT 3 TRÆSNIT I TEXTEN.

CHRISTIANIA,
GRØNDAHL & SØNS BOGTRYKKERI.
1887.

THE NORWEGIAN NORTH-ATLANTIC EXPEDITION

1876—1878.

THE NORTH OCEAN,

Its Depths, Temperature and Circulation

BY

H. MOHN.

WITH 48 PLATES AND MAPS, AND 3 WOODCUTS.

CHRISTIANIA.
PRINTED BY GRØNDAHL & SØN.
1887.

Indhold.

Index.

Rettelser.

Side		staar	læs
48	No. 102	$t = 6^0.01$	$t = 6^0.16$
48	No. 134	$t_r = 6^0.0$	$t_r = 6^0.9$
49	No. 157	$t = 8^0.7$	$t = 8^0.8$
49	No. 158	$t = 9^0.0$	$t = 8^0.7$
55	No. 283	$t_r = 4^0.79$	$t_r = 4^0.74$
70	Linie 1 f. o.	Pl. XIV	Pl. XV
138	— 6 f. n.	Pl. XII	Pl. XIII
143	— 17 f. n.	Pl. XXVII	Pl. XXVIII.

Errata.

Page		for	read
48	No. 102	$t = 6^0.01$	$t = 6^0.16$
48	No. 134	$t_r = 6^0.0$	$t_r = 6^0.9$
49	No. 157	$t = 8^0.7$	$t = 8^0.8$
49	No. 158	$t = 9^0.0$	$t = 8^0.7$
55	No. 283	$t_r = 4^0.79$	$t_r = 4^0.74$
70	Line 1	Pl. XIV	Pl. XV
138	— 5 from bottom	Pl. XII	Pl. XIII
143	— 19 - -	Pl. XXVII	Pl. XXVIII.

I.

Nordhavets Dybder.

I sin Afhandling "Apparaterne og deres Brug" har Captein Wille gjort Rede for de Methoder, ved hvilke Havets Dybder paa den norske Nordhavs-Expedition ere fundne ved Hjelp af Lodskud, og givet en Tabel over disse med tilhørende Bredder og Længder. (Side 30—33).

Ved en Discussion af en Række Experimenter med Piezometer, som jeg udførte paa Expeditionens tredie Togt i 1878, og som findes meddelt som 4de Del af denne Afhandling, er jeg kommet til det Resultat, at den sandsynlige Feil af en Dybdebestemmelse, udført ved Lodning efter den paa vor Expedition benyttede Methode, er $\pm$ 1.66 Favn.

Til et Lodskud hører, foruden Angivelse af Dybden, ogsaa Stedets Bredde og Længde. Sættes den sandsynlige Fejl af hver af disse Bestemmelsesstykker til $\pm$ 1 Bueminut (Storcirkel) (à 1013 eng. Favne), faar man den sandsynlige Feil af en Positionsbestemmelse lig $\pm$ 1013 $\sqrt{2}$ Favne eller $\pm$ 1432 Favne. Har nu Havbunden en Heldning i, vil Usikkerheden i Stedbestemmelsen foraarsage Fejl i Dybdebestemmelsen for det ved den angivne Bredde og Længde betegnede Punkt, der ligge mellem Nul og 1432 tang i Favne, i Gjennemsnit altsaa af 1432 tang $\frac{1}{2}$ i Favne. Den sandsynlige Feil af et Lodskud paa en bestemt Bredde og Længde bliver saaledes gjennemsnitlig:

$$\triangle h = \pm \sqrt{(1.66)^2 + (716 \text{ tang } i)^2} \text{ Favne}$$

og i Maximum $\triangle h = \pm \sqrt{(1.66)^2 + (1432 \text{ tang } i)^2}$ Favne

hvorefter den følgende Tabel er beregnet

i	$\triangle$h i Gjennemsnit	$\triangle$h Max.
0°	1.66	1.66
1°	12.6	25.0
2°	25.1	50.0
3°	37.6	75.1
4°	50.1	100.2

I den sydlige Del af vort Nordhav er den gjennemsnitlige Stigning af Havbunden fra det største Dyb til Kysterne af Island, Færøerne, Norge og mod Østhavet 18′ 17″ (1:188) og heraf faaes den gjennemsnitlige sandsynlige Fejl af en Dybdeangivelse $\pm$ 4.2 Favn. I den nordlige Del af Havet, mellem Grønland og Spidsbergen er den gjennemsnitlige Stigning af Havbunden 26′ 28″ (1 : 129) og $\triangle$h i Gjennemsnit $\pm$ 5.8 Favn.

I.

Depths of the North Ocean.

In his Memoir on "The Apparatus and How Used," Capt. Wille, R. N., has explained the methods by which the depths of the sea on the Norwegian North-Atlantic Expedition were determined by soundings, and has given a Table containing them, together with the latitude and longitude (p. 30—33).

When discussing a series of experiments taken with the piezometer on the third cruise of the Expedition, in 1878, and described in the last Section of this Memoir, I arrived at the result, that the probable error of a depth-determination by sounding as carried out on our Expedition, is $\pm$ 1.66 fathoms.

Exclusive of depth, a sounding has also to include a statement of latitude and longitude. Assuming the probable error in each of these determinations at $\pm$ 1 minute of arc (Great Circle) — or 1013 English fathoms — the probable error of a determination of position will be $\pm$ 1013 $\sqrt{2}$ fathoms, or $\pm$ 1432 fathoms. Now, if the sea-bed has a decline of i, the uncertainty in a determination of position must accordingly occasion an error in the determination of depth for the point indicated by the given latitude and longitude lying between zero and 1432 tan i fathoms — on an average of 1432 tan $\frac{1}{2}$ i fathoms. Hence, the probable error of a sounding in any given latitude and longitude, will average: —

$$\triangle h = \pm \sqrt{(1.66)^2 + (716 \tan i)^2} \text{ fathoms,}$$

and maximum $\triangle h = \pm \sqrt{(1.66)^2 + (1432 \tan i)^2}$ fathoms,

from which the following Table has been computed —

i	h on an average	$\triangle$h max.
0°	1.66	1.66
1°	12.6	25.0
2°	25.1	50.0
3°	37.6	75.1
4°	50.1	100.2

In the southern part of our North Ocean, the average rise of the sea-bed from its greatest depth to the coasts of Iceland, the Færoes, Norway, and also towards the Barents Sea, is 18′ 17″ (1 : 188), which gives the average probable error of a depth-determination $\pm$ 4.2 fathoms. In the northern part of the said Ocean, between Greenland and Spitzbergen, the average rise of the sea-bed is 26′ 28″ (1 : 129) and $\triangle$h on an average $\pm$ 5.8 fathoms.

Da Havbundens Skraaninger tildels overskride 4°, som udenfor Vesteraalen, kan Dybden paa saadanne Steder være ansat over 100 Favne fejlagtigt. Dette fremlyser ogsaa gjennem den grafiske Fremstilling, idet Ligedybde-Linierne ligge meget tæt paa saadanne Partier. Det Billede, som disse give af Havbunden, bliver kun lidet fortrukket.

Til Construction af Dybdekartet (Pl. I) har jeg bebenyttet følgende Kilder.

Lodskud fra den norske Nordhavs-Expedition 1876—78.[1]

Lodskud tagne paa det norske Oplodningsdampskib "Hansteens" aarlige Togter 1867—1885 fra Christianiafjordens Munding til Vestfjorden og udenfor Vardø samt i Varangerfjorden.[2]

De norske Kystkarter, navnlig Finmarkens Kyst. Ældre Lodninger.[3]

De norske, danske og britiske Nordsøkarter.

De tyske "Pommerania" Expeditioner. 1871 og 1872.[4]

De britiske "Lightning" (1868), "Porcupine" (1869), "Knight-Errant" (1880) og "Triton"-Expeditioner (1882).[5]

Den britiske "Bulldog" Expedition 1860.[6]

De danske Sokarter over Færøerne og Island.

De danske "Fylla" og "Ingolf" Expeditioner 1877—79.[7]

Scoresby's Dybdeangivelser fra Jan Mayen.[8]

[1] Capt. Wille, Apparaterne og deres Brug. Side 30—33. Ogsaa meddelt i denne Afhandlings anden Del sammen med Temperaturobservationerne.

[2] Norge. Oversigtskart over Dybde- og Højdeforholde. Udgivet af Norges geografiske Opmaaling 1886.

[3] Kart over den norske Kyst. Fra Kvalø og Grøtsund til Søroen. Fra Søroen til Nordkap. Fra Nordkap til Tanahorn. Fra Tanahorn til Grændsen mod russisk Lapland.

[4] Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Ostsee im Sommer 1871 auf S. M. Avisodampfer Pommerania. Bericht von der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel.

Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Nordsee im Sommer 1872. Bericht u. s. w.

[5] Proceedings of the Royal Society, Vol. XVIII, No. 121. Preliminary Report of the Scientific Exploration of the Deep Sea in H. M. Surveying-vessel "Porcupine" during the Summer of 1869.

C. Wyville Thomson. The Depths of the Sea. — Exploration of the Faroe Channel during the Summer of 1880 in H. M. hired S. "Knight Errant" by Staff- Commander Tizard, R. N. and John Murray; from the Proceedings of the Royal Society of Edinburgh, Session 1881—82.

Die Lothungen und Temperaturmessungen des "Triton" in der Farö-Shetland-Rinne im Sommer 1882. Annalen der Hydrographie und Maritimen Meteorologie. 1883. S. 612.

[6] Britiske (Arctic Ocean) og Danske Søkarter.

[7] Geografisk Tidskrift, udg. af Bestyrelsen for det kongelige danske geografiske Selskab: 1878, S. 97; 1879, S. 46; 1880 S. 47 fgg. samt Manuskript (Søkaart-Archivet ved Capt. Hoffmeyer).

[8] An Account of the Arctic Regions. Vol. I. S. 156.

The slopes of the sea-bed exceeding in some localities 4° — off Vesteraalen, for instance — the depth may, perhaps, there have been given up to 100 fathoms erroneously. This is likewise evident from the diagrammatic representation, the lines of equal depth lying very close together in such places. The image given by those lines of the seabottom, exhibits but a very slight dislocation.

For constructing the Contour-Map (Pl. I), I made use of the following Works of Reference: —

Soundings from the Norwegian North-Atlantic Expedition, 1876—78.[1]

Soundings taken on board the Coast-Survey SS "Hansteen," during her annual cruises (1867—85), from the mouth of the Christianiafjord to the Vestfjord, and off Vardø, as also in the Varangerfjord.[2]

The Norwegian Coast-Charts, in particular those of the Finmark coast. Older soundings.[3]

The Norwegian, Danish, and British North-Sea Charts.

The German "Pommerania" Expeditions, 1871 and 1872.[4]

The British Expeditions with the "Lightning" (1868), the "Porcupine" (1869), the "Knight Errant" (1880), and the "Triton" (1882).[5]

The British "Bulldog" Expedition, 1860.[6]

The Danish Sea-Charts of the Færoes and Iceland.

The Danish "Fylla" and "Ingolf" Expeditions, 1877—79.[7]

Scoresby's depth-determinations from Jan Mayen.[8]

[1] Capt. Wille. The Apparatus and How Used, p. 30—33. Also communicated in the Second Part of this Memoir, along with the observations on temperature.

[2] Norge. Oversigtskart over Dybde- og Højdeforholde. Published by the Norwegian Geographical Survey, 1886.

[3] Chart of the Norwegian Coast: — from Kvalø and Grøtsund to Søroen; from Søroen to the North Cape; from the North Cape to Tanahorn; from Tanahorn to the confines of Russian Lapland.

[4] Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Ostsee im Sommer 1871 auf S. M. Avisodampfer Pommerania. Bericht von der Commission zur wissenschaftlichen Untersuchung der deutschen Meere in Kiel.

Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Nordsee im Sommer 1872. Bericht u. s. w.

[5] Proceedings of the Royal Society, Vol XVIII, No. 121. Preliminary Report of the Scientific Exploration of the Deep Sea in H. M. Surveying Vessel "Porcupine" during the Summer of 1869.

C. Wyville Thomson. The Depths of the Sea. — Exploration of the Faroe Channel during the summer of 1880 in H.M. hired S. the "Knight Errant," by Staff-Commander Tizard, R.N. and John Murray; from the Proceedings of the Royal Society of Edinburgh, Session 1881—82.

Die Lothungen und Temperaturmessungen des "Triton" in der Farö-Shetland-Rinne im Sommer 1882. Annalen der Hydrographie und maritimen Meteorologie, 1883, p. 612.

[6] British (Arctic Ocean) and Danish Sea-Charts.

[7] Geografisk Tidskrift, udg. af Bestyrelsen for det kongelige danske geografiske Selskab: 1878, p. 97; 1879, p. 46; 1880, p. 47; and Manuscript (Søkaart-Archivet), kindly sent me by Capt. Hoffmeyer.

[8] An Account of the Arctic Regions, Vol. I, p. 156.

De tyske Nordpol-Expeditioner med "Germania" og "Hansa" 1868—70.[9]

De Svenske Expeditioner med "Sofia" (1868) og "Polhem" (1873).[10]

De østerrigsk-ungarske Expeditioner med "Isbjørn" (1871) og "Tegetoff" (1872).

De hollandske Expeditioner med "Willem Barents" 1878 og 1879.[12]

Den russiske "Samojed" Expedition. 1876.[13]

Som Grundlag for Dybdekartet construerede jeg et Kart i stereografisk Projection med Midtpunkt i 70° Nord Bredde, 5° Østlig Længde (Greenwich) i Maalestokken 1 : 3000000. Paa dette Kart afsattes de til min Raadighed staaende Lodskud, eller indtegnedes Isobather efter ældre Karters Lodskud, alt efter engelske Favne. Da et Bueminut paa Kartet svarer til 0.6 Millimeter, kunde Lodskuddenes Plads afsættes med en Nøjagtighed, der fuldkommen svarer til deres sandsynlige Usikkerhed.

Efter de saaledes afsatte Lodskud droges Linier — Isobather — gjennem de Punkter, der havde samme Dybde, for hver 100 engelske Favnes Dyb. Pl. I er en Copi i Maalestokken 1 : 7000000 af det originale Dybdekart.

Da jeg fra først af har benyttet den engelske Favn som Maal for Dybderne, dels af skyldigt Hensyn til vore Forgjængere, de britiske og amerikanske Dybsø-Expeditioner, dels af Bekvemmelighedshensyn, da der hidtil i de fleste oceanografiske Arbejder er brugt dette Maal, kommer jeg i disse Afhandlinger til fremdeles at benytte det. Men da jeg paa den anden Side ikke kan andet end anerkjende Rigtigheden af de Betragtninger, der fordre Metermaalet saavel for Dybderne i Havet som for Højder og Udstrækninger paa Landjorden, har jeg i Pl. II givet et Oversigtskart over Nordhavets Dybder i metrisk Maal, med Isobather for hver 200 Meter. Herved er skeet fuld Tilslutning til det af Deutsche Seewarte i dets "Segelhandbuch für den atlantischen Ozean" givne nyeste Kart over Nordatlanterhavets Dybder.

I den mindre Maalestok, hvori Kartet Pl. I er tegnet, har der ikke været Rum til at medtage alle de benyttede

---

[9] Zweite Deutsche Nordpolfahrt. II, 5. S. 621—629.
Capt. Koldewey har stillet til min Disposition et Manuskriptkart med Lodskud fra Grønlandshavet, hvorfor jeg her aflægger min skyldige Tak.

[10] Manuskript-Tabel ved Godhed af Com.-Capt. Malmberg, Stockholm. — Svenska Polar-Expeditionen År 1868 med Kronoångfartyget „Sofia". Reseskizzer af Th. M. Fries och C. Nyström. Om disse Lodskuds udmerkede Overensstemmelse med vore se Capt. Wille "Apparaterne etc." S. 24. — Redogjörelse för en Expedition till Mynningen af Jenissei och Sibirien År 1875 af A. E. Nordenskiöld. S. 109.

[11] Petermanns Geographische Mittheilungen 1878. S. 345.

[12] Manuskript, ved Godhed af Prof. Buijs Ballot. Meteorologische Waarnemingen en Diepzeeloodingen. Gedaan aan Bord van "De Willem Barendsz" . . . . in den Zoomer van 1878. — Do. f. 1879.

[13] Geografischeskaja Iswestja 1878. XIV, S. 350. — Engelske og danske Søkarter.

The German North-Pole Expeditions with the "Germania" and the "Hansa," 1868—70.[9]

The Swedish Expeditions with the "Sofia" (1868) and the "Polhem" (1873).[10]

The Austrio-Hungarian Expeditions with the "Isbjorn" (1871) and the "Tegetoff" (1872).[11]

The Dutch Expeditions with the "Willem Barents," 1878 and 1879.[12]

The Russian "Samojed" Expedition, 1876.[13]

As basis for the Contour-Map I constructed a chart on stereographic projection, with the centre in lat. 70° N, long 5° E (Greenwich); scale 1 : 3000000. On this chart I set down the soundings at my command, or entered isobaths from soundings of older charts, without exception in English fathoms. A minute of arc on the chart corresponding to 0.6 millimetres, the position of the soundings could be given with an accuracy fully equal to their probable uncertainty.

From the soundings thus set down were drawn lines — isobaths — through points of equal depth, for every 100 English fathoms. Pl. I gives a copy on the scale 1 : 7000000 of the original Contour-Map.

Having commenced with using the English fathom as a standard of measurement to determine depth, partly from due regard to our predecessors who conducted the British and American Deep-Sea Expeditions, partly on the score of convenience, and the authors of most oceanographic works having hitherto adopted that measure, I shall still continue to use it in these Memoirs. But, on the other hand, as I cannot but admit the correctness of the views that advocate the metre as a standard of measurement alike for the depth of the sea and for altitude and extension on dry land, I have given in Pl. II a Synoptical Chart of the Depths of the North Ocean on the metre-standard, with isobaths for every 200 metres. Thus full agreement is attained with the latest chart of North-Atlantic Depths published by Deutsche Seewarte in its "Segelhandbuch für den Atlantischen Ozean."

The smaller scale on which the chart Pl. I is drawn, does not afford sufficient space for noting all the soundings

---

[9] Zweite Deutsche Nordpolfahrt, II, 5, p. 621—629.
Capt. Koldewey has placed at my disposal a manuscript chart, with soundings from the Greenland Sea, for which I beg to tender him my respectful thanks.

[10] Manuscript Table, kindly lent by Capt. Malmberg, Stockholm. — Svenska Polar-Expeditionen År 1868 med Kronoångfartyget "Sofia." Reseskizzer af Th. M. Fries och C. Nyström (Respecting the remarkable agreement of these soundings with ours, see Capt. Wille. The Apparatus, &c., p. 24). — Redogjörelse för en Expedition till Mynningen af Jenissei och Sibirien år 1875, af A. E. Nordenskiöld, p. 109.

[11] Petermanns Geographische Mittheilungen, 1878, p. 345.

[12] Manuscript, kindly lent by Prof. Buijs Ballot. Meteorologische Waarnemingen en Diepzeeloodingen. Gedaan aan Bord van "De Willem Barendsz" . . . . in den Zoomer van 1878. — Do. for 1879.

[12] Geografischeskaja Iswestja, 1878, XIV, p. 350. — British and Danish Sea-Charts.

Lodskud. Hvor Lodskuddene ligge meget tæt, ere kun de mest characteriserende anførte i Kartet.

Som man ser, ere Lodskuddene ingenlunde jevnt fordelte over Havet. De findes tættest ved Kysterne, paa Kystbankerne og langs de af Expeditionerne udsejlede Linier. Mellem disse Linier staar der større tomme Rum. Som en Følge af denne Ujevnhed i Lodskuddenes Fordeling lader Havbundens Topografi sig ikke paa alle Steder fremstille med den samme Sikkerhed. Bedst bestemte ere Kystbankerne og Bundens Skraaning mod Dybet paa den østlige Side af dette, fra Nordsøen til Nord-Spidsbergen, Øst-Havet, Strækningen fra Shetland over Færøerne og Island til Danmarkstrædet, Bankerne omkring disse Øer, Bankerne og Skraaningen mod Dybet udenfor Øst-Grønland fra den 70. til den 75. Breddegrad. Ganske godt bestemte ere ogsaa de to Maximaldybder paa over 2000 Favne. Paa alle disse Strækninger lade Isobatherne sig drage efter Dybdetallene uden Tvetydighed.

Men der er andre Strækninger, hvor de forhaandenværende Lodskud tillade forskjellige Tydninger af Havbundens Form, nemlig:

a) Strækningen mellem Island, Færøerne og Rockall-Banken; her mangle Lodninger paa de dybere Partier. Elisabeth-Banken, der paa tidligere Karter findes aflagt søndenfor Island, har jeg ikke taget med, da dens Existence er yderst tvivlsom, idet den forgjæves har været eftersøgt af danske Krigsskibe i de senere Aar.

b) Vestsiden af Danmark-Strædet, hvor selve Kystens Form endnu er ubekjendt.

c) Strækningen mellem Jan Mayen og Island. Det er sikkert, at vi her have en Rende med over 1000 Favnes Dyb, men Retningen af denne Rendes dybere Partier lader sig ikke angive med Sikkerhed. Kartets Isobather her ere trukne efter de Vink, som Studiet af Temperaturens Fordeling i Dybet har givet mig. Skraaningerne paa begge Sider af Renden kunne ved nøjere Undersøgelser komme til at se anderledes ud. Lodskuddet 700 Favne søndenfor Jan Mayen hidrører fra "Hansa" og maa ansees paalideligt, da der blev taget Bundprøve med Loddet. Linien for 100 Favne er trukket efter Scoresby's Opgave, at der i en Afstand af 11 til 12 leagues i SSE for Sydkap findes Ankergrund paa 35 til 36 Favne Vand. I Sydost for Jan Mayen turde den stejle Skraaning mod Dybet blive modificeret ved nye Lodninger.

d) Tegningen af den store Indbugtning i 1300 Favnes Dyb nordenfor Jan Mayen er mig noget problematisk. Lodskud mangle. Desværre hindrede Isen os fra at komme hid, saaledes som det laa i min Plan.

e) Mellem Jan Mayen og Beeren-Eiland løfter sig aabenbart en undersøisk Ryg. Men om den er ganske

made use of. Where the soundings lie very close together, the most characteristic only have been set down on the chart.

As will be seen, the soundings are far from equably distributed throughout the sea. They occur closest in the vicinity of the coasts, on the coastal banks, and along the lines forming the track of the Expedition. Between these lines, extend the larger unnoccupied spaces. Owing to this unequal distribution of the soundings, the topography of the sea-bed cannot be everywhere represented with equal certainty. The best-defined portions are the coastal banks, and the slope of the bottom towards the deep on the eastern side of the latter from the North Sea to North Spitzbergen, likewise the Barents Sea, the tract stretching from Shetland past the Færoes and Iceland to Denmark Strait, the banks surrounding those islands, and the banks and decline towards the deep off East Greenland, from the 70th to the 75th parallel of latitude. Well defined also are the two maximum-depths, each exceeding 2000 fathoms. Through all these tracts of ocean, isobaths admit of being drawn from the figures of depth, without ambiguity.

But there are other tracts, in which the soundings taken will allow of a different explanation being given to the form of the sea-bed, viz.: —

a) The tract between Iceland, the Færoes, and the Rockall Bank; here we have no soundings in the deeper parts. The Elizabeth Bank, placed on older charts south of Iceland, I have not set down, its existence being very doubtful, Danish men-of-war having of late years sought in vain to find it.

b) The west side of Denmark Strait, where the contours even of the coast are still unknown.

c) The tract between Jan Mayen and Iceland. It is evident that we have here a channel more than 1000 fathoms deep; but the direction of the deeper parts cannot be given with certainty. The isobaths on the chart have been drawn from the results attained by a study of the distribution of the temperature in the deep strata. The slopes on either side of the channel will, perhaps, after a closer examination, be found to have a different appearance. The sounding located 700 fathoms south of Jan Mayen, was taken on board the "Hansa," and may be considered reliable, a sample of the bottom having been brought up with the lead. The hundred-fathom line has been drawn according to Scoresby's statement, viz., that at a distance of 11 or 12 leagues SSE from South Cape there is anchorage in 35 or 36 fathoms of water. South-east of Jan Mayen, the abrupt slope towards the deep will possibly have to be modified after subsequent soundings.

d) The figure of the large submarine bay, at a depth of 1300 fathoms, north of Jan Mayen, appears to me somewhat problematical. Soundings there are none. Unfortunately, ice prevented us from reaching up to that locality, as I had purposed according to my original plan.

e) Between Jan Mayen and Beeren Eiland rises manifestly a submarine ridge. But whether this ridge

sammenhængende paa hele Strækningen eller gjennembrudt paa Midten i en Dybde af 1500 Favne, kan ikke med Sikkerhed afgjøres. Efter Temperaturforholdene i Dybet har jeg henlagt Lodskuddet paa 1500 Favne (Station No. 298) til det nordlige Bækken.

f) Lodskuddet 1200 Favne (Station No. 303, 75° 12′ N.Br., 3° 2′ E. L.) har voldt mig ikke lidet Besvær. Det ligger midt imellem lutter større Dybder. Jeg har tegnet en Top, men det kan derfor gjerne være Tilfældet, at man har en fra Nord eller Syd udgaaende Ryg, der indeslutter en østenfor samme liggende Fordybning. Denne Usikkerhed har Indflydelse paa Fremstillingen af Partiet ved den 77. Breddegrad.

g) I Nordvest for Spidsbergen er det tegnede Bundrelief til en vis Grad hypothetisk, med den langstrakte Bank paa mindre end 500 Favne. Paa dennes Midtparti findes nemlig ikke noget Lodskud.

Førend jeg beskriver det ved Lodningerne vundne Billede af Havbundens Form, vil det være hensigtsmæssigt at fastsætte nogle geografiske Benævnelser paa de forskjellige Dele af det europæiske Nordhav.

Nordsøens nordlige Grændse sættes efter en Linie fra Stad til Shetland og Orknøerne. Mod Nordvest støder den til *Færø-Shetland-Renden* (Lightning Channel) mellem Shetland og Færøerne.

Det norske Hav begrændses af Linien Stad—Shetland—Færøerne — Øst-Island — Jan Mayen — Syd-Spidsbergen — Nordkap— den norske Kyst fra Nordkap til Stad.

Grønlandshavet begrændses af Nord-Island, Øst-Grønland, Vest-Spidsbergen, Linien Spidsbergen—Jan Mayen—Nord-Island. Gjennem *Danmark-Strædet* mellem Island og Grønland munder Grøndlandshavet ud i Nord-Atlanterhavet, gjennem *Jan-Mayen-Renden* staar det i Forbindelse med den sydlige Del af det norske Hav.

Øst-Havet begrændses af Linien Syd-Spidsbergen—Nordkap, Finmarkens Kyst, Ruslands Nordkyst, Novaja-Semlja, Øst-Spidsbergen.

Havbundens Form. I Kartets sydvestlige Hjørne møde vi Nordatlanterhavets Dybder, hvis Arme omspænde Rockall-Banken og som støde op til Bankerne vestenfor Irland, Skotland og Færøerne, søndenfor og vestenfor Island. De britiske Øer ligge samtlige paa den Bank, der danner Nordsøens Bund, og som har et brat Affald mod Vest. Mellem den sydvestlige Færø-Bank og Nordsøbanken, i Nord for Hebriderne, i Nordvest for Orknøerne, er der en sammenhængende smal Ryg, *Wyville Thomson-Ryggen*, der paa Dybder større end 330 Favne fuldstændig adskiller Nordatlanterhavets Dyb fra vort Nordhavs. Denne Adskillelse fortsættes uden Afbrydelse af dybere Steder over Færø-Bankerne og videre mod Nordvest over Island indtil Grønland. Mellem Færø-Banken og Øst-Island hæver sig en bredere Ryg paa omkring 250 Favnes Dybde. Dens dybeste Punkt ligger paa ikke mere end 277 Favne,

be wholly continuous throughout the entire tract or disrupted in the middle at a depth of 1500 fathoms, cannot with certainty be determined. Reasoning from the temperature in the deep strata, I have placed the 1500-fathom sounding (Station No. 298) in the north basin.

f) The 1200-fathom sounding (Station No. 303, lat. 75° 12′ N, long. 3° 2′ E) has occasioned me not a little perplexity. It lies midway between great depths. I have figured a summit; but just as likely may a ridge be found to extend from the north or south, enclosing an eastward-lying recess. This uncertainty exerts its influence when figuring the part of the bed on the 77th parallel of latitude.

g) North-west of Spitzbergen, the contours of the bottom, as given in the plate, with the far-stretching bank at a depth of less than 500 fathoms, is to a certain extent hypothetical. In the middle part, namely, no sounding has yet been taken.

Before proceeding to describe the figure of the sea-bed as shown by the soundings, it will be advisable to state a few geographical appellations for the various parts of the North Ocean of Europe.

The northern boundary of the *North Sea* is held to be congruent with a line extending from Stad in Norway to the Shetland and Orkney Islands. Towards the north-west, it meets the *Færoe-Shetland Channel* (Lightning-Channel), between Shetland and the Færoes.

The Norwegian Sea is bounded by the line Stad—Shetland—Færoes—East Iceland—Jan Mayen—South Spitzbergen—North Cape—Norwegian coast from North Cape to Stad.

The Greenland Sea is bounded by North Iceland, East Greenland, West Spitzbergen, and the line Spitzbergen—Jan Mayen—North Iceland. Through the *Denmark Strait*, between Iceland and Greenland, the Greenland Sea disembogues into the North Atlantic; through the *Jan-Mayen Channel* it is connected with the southern part of the Norwegian Sea.

The Barents Sea is bounded by the line South Spitzbergen—North Cape, as also the Coast of Finmark, the North Coast of Russia, Novaja-Semlja, and East Spitzbergen.

Contours of the Sea-Bed. — In the south-west corner of the chart, we have the depths of the North Atlantic, the arms of which enclose the Rockall Bank and meet the banks west of Ireland, Scotland, and the Færoes, as also those south and west of Iceland. The British Islands rest one and all on the bank forming the bed of the North Sea and having a steep decline towards the west. Between the south-western Færoe-Bank and the North-Sea Bank, north of the Hebrides, extends, north-west of the Orkney Islands, a narrow continuous ridge, the *Wyville-Thomson Ridge*, which, at depths of more than 330 fathoms, wholly separates the North-Atlantic Deep from that of the North Ocean. This separation proceeds continuously, without interruption from deeper parts, past Iceland up to Greenland. Between the Færoe-Bank and East Iceland rises a broader ridge, up to a depth of about 250 fathoms. Its deepest summit lies

nærmest Færø-Banken. I Danmarkstrædet, mellem Island og Grønland, ligger ogsaa en Ryg omtrent midt i Strædet, paa 66° N.Br., hvor Dybden kun naar 319 Favne. Det europæiske Nordhav er saaledes i Dybet fuldkommen afstængt fra Atlanterhavets Dyb. Kun i de øverste 300 Favne kunne disse Have udvexle sine Vandmasser. Merkelig er den ringe Forskjel, der er paa Maximumsdybderne i de 3 Aabninger mellem begge Have — Færø-Shetland-Renden, Færø-Island-Flakket, Danmarkstrædet: 330—277—319 Favne.

Nordsøen er i det hele taget grund; i den sydlige Del er Dybden kun omkring 20 Favne, i den nordlige 50—100 Favne. Langs Norges Vestkyst, fra Bankerne udenfor Romsdalskysten, skjærer sig en vel afgrændset dybere Rende — *den Norske Rende* —, der fortsætter, med sin indre Skraaning meget nær Norges Kyst, rundt Lindesnes ind i Skagerak til henimod den svenske Kyst. Her i Skagerak har den, udenfor Arendal, sin største Dybde, 443 Favne. Dens grundeste Del ligger udenfor Bømmelen paa 140 Favne.

Imellem Shetland og Færøerne skyder *Færø-Shetland-Renden* sig mod Sydvest ned fra Nordhavets Dyb. Rendens Bund ligger paa c. 600 Favnes Dyb. Den begrændses mod Sydvest af Wyville Thomson Ryggen.

Under 10° W. Længde, ganske lidt søndenfor Polarcirkelen, vise Lodningerne fra "Ingolf" (1879) et Indsnit henimod Islandsbanken. Dets Axe peger mod Hekla.

Det europæiske Nordhavs Dyb er ved den fra Jan Mayen mod ENE i Retning af Beeren Eiland gaaende undersøiske Ryg afdelt i to Bassiner. Det sydlige Bassin svarer nærmest til det norske Hav. Dets dybeste Parti — *Det Norske Dyb* — ligger i Vest for Norge, Nordost for Island og Sydost for Jan Mayen. Paa 68° N. Br. og 3° W. Længde er Dybden størst, over 2000 Favne. Dybets Axe er her meridional, men mellem Jan Mayen og Lofoten—Vesteraalen strækker sig dets umiddelbare Fortsættelse med Axen vinkelret mod den første og med betydelige Dybder, 1600—1800 Favne. Jeg kalder dette Parti *Lofot-Dybet*. I Vinkelen mellem Lofotdybet og Norskedybet skyder de norske Kystbankers Fortsættelse mod Dybet bastionformet frem. Mod Vest staar Grøndlandshavet gjennem *Jan-Mayen-Renden*, paa 1100 Favnes Dyb, mellem denne Ø og Island i direkte Forbindelse med Norskedybet.

Nordenfor "*Tverryggen*" mellem Jan Mayen og Beeren-Eiland sænker Grønlandshavets største Dyb sig mellem Grønland og Spidsbergen til over 2650 Favne, hvilket Dyb loddedes af "Sofia" Expeditionen i 1868. Jeg kalder dette Dyb *Svenske-Dybet*. Dets vestlige Del er endnu ganske ubekjendt, da Havet her dækkes af Grønlandsisen,

not more than 277 fathoms beneath the surface of the sea, nearest the Færoe-Bank. In Denmark Strait, between Iceland and Greenland, also occurs a ridge, well-nigh in the middle of the strait, lat. 66° N, where the depth reaches only 319 fathoms. Hence the North Ocean of Europe is cut off in its lower strata from the deeps of the Atlantic. In the upper 300 fathoms only is it possible for the two to mingle their waters. Remarkable may be termed the slight difference in the maximum-depths throughout the 3 openings between the said oceans, viz., the Færoe-Shetland Channel, the Færoe-Iceland Flat, and Denmark Strait, viz., 330—277—319 fathoms.

The North Sea is on the whole shallow: in its southern part the depth averages only about 20 fathoms, in its northern 50—100 fathoms. Along the West Coast of Norway, from the banks off the coast of Romsdal, extends a comparatively deep, well bounded channel — the *Norwegian Channel* — which passes on, with its inner declivity very near the Norwegian Coast, round Lindesnes (the Naze) into the Skagerak, nearly reaching the coast of Sweden. Here, in the Skagerak, off Arendal, the channel attains its greatest depth — 443 fathoms. Its shallowest part lies off Bommelen — 140 fathoms.

Between Shetland and the Færoes, the *Færoe-Shetland Channel* strikes down towards the south-west from the deeps of the North Ocean. The bottom of the channel lies at a depth of about 600 fathoms. On the south-west, it is bounded by the Wyville-Thomson Ridge.

In long. 10° W, a very little south of the Polar Circle, the soundings taken on board the "Ingolf" (1879) show an incision in the direction of the Iceland Bank. Its axis points towards Hekla.

The deeps of the North Ocean of Europe are divided into two basins by the ridge extending ENE from Jan Mayen in the direction of Beeren Eiland. The southern basin approximates closest the Norwegian Sea. Its deepest part — the *Norway-Deep* — lies west of Norway, north-west of Iceland, and south-east of Jan Mayen. In lat. 68° N and long 3° W the depth is greatest — more than 2000 fathoms. The axis of the deep is meridional; but between Jan Mayen and Lofoten—Vesteraalen its direct continuation extends onward, with the axis at right angles to the former, and having very considerable depths — 1600 to 1800 fathoms. I have called this part the "*Lofoten-Deep*." In the angle between the Lofoten-Deep and the Norway-Deep, the continuation of the Norwegian coastal banks extends, bastion-like, towards the deep. To the west we have the Greenland Sea, passing through the *Jan-Mayen Channel*, at a depth of 1100 fathoms, between Jan Mayen and Iceland, in direct communication with the Norway-Deep.

North of the "*Transverse Ridge*," between Jan Mayen and Beeren Eiland, the greatest depth of the Greenland Sea, between Greenland and Spitzbergen, is upwards of 2650 fathoms, a depth sounded on the "Sofia" Expedition, in 1868. This deep I shall call the "*Swedish Deep*." Its western part is still wholly unknown, the sea being

som paa disse høje Bredder endnu ikke er gjennemfaret af nogen Expedition. Mod Sydvest grunder det i NNW for Jan Mayen op til 1300 Favne, et Parti, jeg efter den tyske Nordfart kalder det „*Tyske Dyb*", og som har sin Fortsættelse dels mod Danmark-Strædet, dels mod Jan Mayen-Renden.

Østenfor Linien Vestspidsbergen—Vesteraalen løfter Bunden sig op til nogle faa hundrede Favnes Dyb mod Østhavet. Dette er overalt forholdsvis grundt. En Bugt paa over 200 Favnes Dyb gaar ind mellem Norge og Beeren Eiland, men østenfor den 30. Længdegrad ere Dybderne kun mellem 100 og 200 Favne over store Strækninger, kun afbrudt af et Par grundere Banker, indtil ind under Kysterne. Fra Murmankysten til Novaja Semlja ere Dybderne under 100 Favne. Fra Østspidsbergen strækker Beeren-Eiland-Banken med udstrakte grunde Strækninger sig sydover til lidt søndenfor denne Ø.

Bundens Heldning fra Kysterne ud mod Dybet er i Regelen ikke jevn. Det første Stykke udenfor Kysten dannes i Almindelighed af en svagere skraanende, forholdsvis jevn Flade, Kystbanken, der i større eller mindre Afstand fra Land, i en mindre eller større Dybde, gaar gjennem en Eg, over til en sterkere Skraaning. Fremtrædende Egge ere i Norge *Storeggen* udenfor Romsdalskysten, hvor Bunden paa en kort Strækning falder fra 100 til 500 Favne og i endnu højere Grad *Vesteraalseggen*, hvor Bunden synker fra 100 til 1500 Favne i Lofotdybet. Mellem disse Steder skyder 200 Favne- Linien udenfor Norges Kyst langt tilhavs og Eggen er ikke meget fremtrædende. Paa lignende Maade har Shetland, Færøerne, Island, Jan Mayen, Grønland, Vestspidsbergen sine Banker med mere eller mindre udprægede Egge som Ydergrændser. Kartet viser dette bedst. Ved Finmarkens Kyst synker Bunden raskt til 100 Favne, men udenfor er Havbunden et udstrakt Flak med svage Bølgeformer.

Ovenfor er nævnt, hvor store de gjennemsnitlige Heldninger af Havbunden i det norske Hav og i det nordlige Grønlandshav ere. Af Kartet vil man bedst se, hvorledes Heldningerne i Virkeligheden ere fordelte. Jo tættere Isobatherne ligge, desto større er Skraaheden. Den sterkeste Heldning have vi fundet i Nordost for Jan Mayen, hvor Dybden naar 1040 Favne (Station No. 227) i en Afstand af 7 Kvartmil fra Land. Hertil svarer en Heldning af 1 : 6.8 eller 8^0 21′. Dette er den umiddelbare Fortsættelse af den gamle Vulkan Beerenbergs Lava-Skraaninger mellem Askekeglen og Havet.[1]

[1] Den norske Nordhavs-Exp. H. Mohn, Geografi og Naturhistorie. S. 23 og Billedet: Beerenberg—Jan Mayen, samt Kart over Jan Mayen.

covered there by the Greenland Ice, which in those high latitudes has not been hitherto penetrated by any Sounding-Expedition. Towards the south-west it gets shallower — north-north-west of Jan Mayen up to 1300 fathoms, a part of this deep which I have called, in honour of the German explorers, the "*German Deep*," and that has its continuation partly towards Denmark Strait, partly towards the Jan-Mayen Channel.

East of the line West Spitzbergen—Vesteraalen, the sea-bed rises towards the Barents Sea up to a few hundred fathoms. The latter is everywhere comparatively shallow. A bay, more than 200 fathoms deep, occurs between Norway and Beeren Eiland; but east of the 30th degree of longitude the depths average only between 100 and 200 fathoms, throughout extensive tracts, broken merely by one or two comparatively shallow banks, till near the coasts. From the Murman coast to Novaja Semlja, the depths average less than 100 fathoms. From East Spitzbergen, the Beeren-Eiland Bank rises, with extensive shallow tracts, in a southward direction, till a little south of that island.

The slope of the bottom from the coasts towards the deep does not as a rule assume a regular character. The first part off the coast is generally constituted by a gently inclining, comparatively even flat — the coastal bank, which, at a greater or less distance from land and a less or greater depth, passes by an "edge" to a steeper decline. Prominent edges in Norway are the "*Storeg*," off the coast of Romsdal, where the bottom throughout a short tract sinks from 100 to 500 fathoms, and more especially the "*Vesteraalseg*," where the bottom sinks from 100 to 1500 fathoms, in the Lofoten-Deep. Between these points, extends the 200-fathom line off the coast of Norway, far out at sea; and the edge is not there very prominent. The banks of Shetland, the Færoes, Iceland, Jan Mayen, Greenland, West Spitzbergen exhibit a similar formation, with more or less prominent "edges" as their outer boundary. Of these, the chart gives the best representation. Along the coast of Finmark, the bottom sinks rapidly down to 100 fathoms; but farther out the sea-bed assumes the character of a wide-extending flat, with gentle undulations.

Above, it has been stated how steep are the average slopes of the sea-bed in the Norwegian and North-Greenland Seas. From the chart, the best idea will be obtained of the actual distribution of these slopes. The steepest decline we found north-east of Jan Mayen, where the depth reaches 1040 fathoms (Station 227) at a distance of 7 nautical miles from land. This corresponds to a slope of 1 : 6.8, or 8^0 21′. These figures represent the direct continuation of the lava-slopes of the extinct volcano Beerenberg — between the ash-cone and the sea.[1] The next-

[1] The Norwegian North-Atlantic Expedition: — Geography and Natural History, by H. Mohn, p. 23, and the Plate representing Beerenberg—Jan Mayen, as also the Map of Jan Mayen.

Den næst sterkeste Heldning finde vi paa Udsiden af Vesteraalseggen. Her voxer Dybden fra 100 Favne til 1500 Favne paa en Afstand af 22.5 Kvartmil, hvortil svarer en Heldning af 1 : 16.3 eller 3⁰ 31′. Den gjennemsnitlige Skraaning af Havbunden er i Norske-Dybet 1 : 188 eller 18′.3, i Svenske-Dybet 1 : 129 eller 26′.5.

steepest decline we meet with on the outer side of the Vesteraalseg. Here the depth increases from 100 to 1500 fathoms throughout a distance of 22.5 naut. miles, to which corresponds a decline of 1 : 16.3, or 3⁰ 31′. The average slope of the sea-bed in the Norway-Deep is 1 : 188, or 18′.3, in the Swedish Deep 1 : 129, or 26′.5.

II.

Havets Temperatur.

1. De benyttede Instrumenter.

Angaaende Iagttagelsen af Havoverfladens Temperatur henvises til min Afhandling „Meteorologi“ Side 46.

Til Expeditionens første Rejse i 1876 var anskaffet 10 Miller-Casella's Dybvandsthermometre af den almindelige Construction og Størrelse (Indfatningsrammen 23 cm.). Disse Instrumenter ere nu saa ofte beskrevne[1], at det ikke her er nødvendigt at beskrive dem nøjere. De vare inddelte i Celsius-Grader og prøvede ved et Tryk af 2.5 Tons pr. Kvadrattomme. De fra Fabrikanten opgivne Correctioner for Tryk kom, som senere skal omtales, ikke til Anvendelse ved Observationernes endelige Beregning. De 9 af disse Instrumenter, der jevnlig anvendtes paa alle Expeditionens tre Togter, ere i det følgende betegnede ved Romertallene I til IX.

I 1876 og 1877 anvendtes nogle faa Gange et Dybvandsthermometer af Negretti & Zambra.[2] Det er U-formet og havde en Vendemekanisme, der ved Ophaling virkede gjennem en Skruepropeller. Da den oprindelige Vendemekanisme virkede saa hurtigt, at man var udsat for, at Thermometret under Søgang kunde vende sig, og derved registrere Temperaturen, førend det havde accommoderet sig, blev Mekanismen af Capt. Wille til Rejsen i 1877 forandret til en langtsomt virkende. Ved Temperaturrækker haledes da Lodlinen, efterat Thermometret havde accommoderet sig i Dybet, ind nogle Favne og firedes atter ud, hvilket gjentoges saamange Gange, at man var sikker paa, at Thermometret var vendt. Derpaa begyndte den egentlige Indhaling. En saadan Operation tog megen Tid, hvorfor Instrumentet sjelden anvendtes. Instrumentet betegnes i det Følgende ved N Z.

[1] Se f. Ex: Wyville Thomson. The Depths of the See. S. 291.
[2] Beskrevet i "Nature," Vol IX. S. 387.

II.

Temperature of the Sea.

1. Instruments.

Respecting the observations taken of the temperature of the sea-surface, I refer to my Memoir — "Meteorology," p. 46.

For the first cruise of the Expedition, in 1876, had been provided 10 deep-sea Miller-Casella thermometers, of the usual construction and size (frame 23 cm.). These instruments have been so often described[1] as to render further description here superfluous. They were divided in degrees centigrade, and had been tested by a pressure of 2.5 tons per square inch. The corrections given by the instrument-maker were not, as will be subsequently explained, made use of when finally reducing the observations. Of these instruments, the 9 in constant use on each of the 3 cruises of the Expedition will be indicated by the Roman letters I to IX.

In 1876 and 1877, a deep-sea thermometer by Negretti and Zambra was used on a few occasions.[2] This instrument is U-shaped and furnished with a mechanism for turning over in the water, which, on hauling it in, acts by means of a small propeller. The original mechanism operating with such rapidity that in a heavy sea the thermometer was liable to turn over and register the temperature before the instrument could accomodate — Capt. Wille gave it, for the cruise in 1877, a slower-acting mechanism. When measuring serial temperatures, the sounding-line was hauled in a few fathoms, as soon as the thermometer had been given time to accomodate in the deep, and then veered out again, the operation being repeated sufficiently often to ensure the thermometer having turned over. Then commenced the final hauling-in. An operation of this kind naturally took up a great deal of time, and hence the instrument was seldom made use of. This thermometer will be indicated by the letters N Z.

[1] See, for example, Wyville Thomson. The Depths of the Sea, p. 291.
[2] Described in "Nature," Vol. IX. p. 387.

I 1877 fik jeg til Foræring af Hr. J. Y. Buchanan, Challenger-Expeditionens Chemiker, et nyt Dybvandsthermometer af en ejendommelig Construction, som han havde opfundet og prøvet paa denne Expedition, og hvilket han kaldte Kviksølvpiezometer. Uagtet kortelig beskrevet af Hr. Buchanan[1], maa jeg dog her give en Beskrivelse af dette Instrument, da det var mig, navnlig i 1877, men ogsaa i 1878, til uvurderlig Nytte som Controlapparat for de Miller-Casella'ske Dybvandsthermometres Trykcorrectioner, foruden som et selvstændigt Dybvandsthermometer, der aldrig kom i Uorden, og som tillod en større Nøjagtighed i Temperaturens Bestemmelse end de ældre Thermometre.

Figur 1 viser Kviksølvpiezometret i halv Maalestok. Det er, som man ser, et Kviksølvthermometer, hvis Beholder A er temmelig stor og ikke beskyttet mod det ydre Tryk. Det i Millimeter paa selve Glasset inddelte Thermometerrør er ombøjet og fyldt med rent Vand fra B til C, forresten med Kviksølv. Dets Ende er *aaben* og udmunder i Koppen D, der er fyldt med Kviksølv. Denne Kop er kugleformet med en Hals, der omslutter Thermometerrøret. Et Stykke Kautschukslange E fæster Koppen til Røret. For at give Vandet Adgang til at trykke paa Kviksølvet i Koppen er Glasstangen eller Glasrøret H stukket imellem Thermometerrøret og Kautschukslangen. En magnetisk Index I af samme Slags som Indexen i Miller-Casella's Thermometer, er indbragt i Vandet over Kviksølvet. Tallene paa Skalaen betegne Centimeter. Instrumentet er, ligesom det nævnte Thermometer, fæstet til en Ebonitplade og staar, naar det bruges, i et Kobberhylster. Det er forfærdiget af Casella i London.

Instrumentet er saaledes construeret, at dets Stand (den Aflæsning, der svarer til Kviksølvtoppen C) afhænger saavel af Temperaturen som af Trykket. Dets Stand ved forskjellige Temperaturer under almindeligt Lufttryk bestemtes ved Sammenligning med Normalthermometret. En Temperaturvariation af 1° C svarer omtrent

[1] Proceedings of the Royal Society 1876. S. 163.

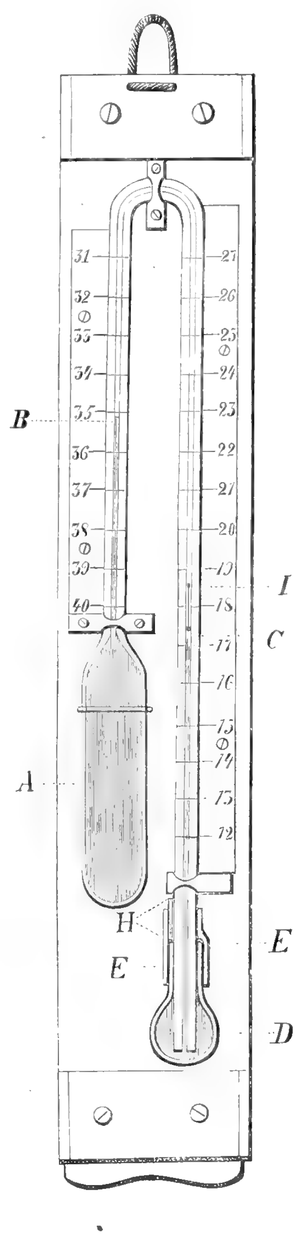


Fig. 1.

In 1877, Mr. J. Y. Buchanan, Chemist to the Challenger Expedition, kindly presented me with a deep-sea thermometer, of a new and peculiar construction, devised by himself and tested on that Expedition, and which he calls the Mercury-Piezometer. Though briefly described by Mr. Buchanan,[1] I must here append a description of this instrument, since it proved in 1877, but also in 1878, of incalculable advantage for controlling the pressure-corrections of the Miller-Casella deep-sea thermometers, not to mention its use as an independent deep-sea thermometer, that never got out of order and which admitted of greater certainty and exactness in determining the temperature than any of the older instruments.

Figure 1 represents the mercury-piezometer, half size. It is, as will at once be seen, a mercury-thermometer, having the bulb A comparatively large and not protected against the outward pressure. The stem, divided into millimetres on the glass itself, is bent round and filled with pure water from B to C — for the rest, with mercury. Its end is *open* and dips into the cup, D, which is filled with mercury. This cup is spherical in shape, with a neck encircling the tube of the thermometer. A piece of india-rubber tubing, E, attaches the cup to the glass stem. That the water may have free admission to press upon the mercury in the cup, the glass rod or glass tube, H, is placed between the stem of the thermometer and the india-rubber tubing. A Magnetic Index, I, similar to the index in the Miller-Casella thermometer, is introduced into the water above the mercury. The figures on the scale indicate centimetres. As with the aforesaid thermometer, this instrument is made fast to an ebonite plate, and the whole rests enclosed within a copper case. It was made by Casella of London.

The instrument is constructed in such a manner, that its reading (the division that corresponds with the top of the mercury, C) depends alike on temperature and on pressure. Its reading at different temperatures under ordinary atmospheric pressure was determined by comparison with the Standard-Thermometer.

[1] Proceedings of the Royal Society, 1876, p. 163.

til 3 mm. paa Skalaen. Naar Instrumentet er i Dybet, virker Havvandets Tryk til at sammentrykke Glasset, det rene Vand i Røret og Kviksølvet. Ved en vis Temperatur vil da Kviksølvtoppen C vise paa højere Tal (mindre Temperatur) end i Luften, da Vandets Sammentrykkelighed er den overvejende. For hver 100 Favnes Dybde er den heraf flydende positive Temperaturcorrection 0°.15 eller 0.4 mm. paa Skalaen. I Havet, hvor Temperaturen i Regelen synker med Dybden, vil saaledes Aflæsningen af Indexens nedre Ende, omgjort til Temperatur og corrigeret for Virkningen af Trykket, give den søgte Temperatur i Dybet. Forøvrigt har Hr. Buchanan vist,[1] at et Kviksølvpiezometer af denne Art kan give en rigtig Temperaturbestemmelse, selv naar Temperaturen stiger svagt med Dybden. En Temperaturtilvæxt med Dybden af mindre end 0°.15 pr. 100 Favne vil paa vort Instrument, som man ser, bringe Kviksølvtoppen C til at vise paa lavere Tal, men Virkningen af Trykket vil være sterkere til at bringe den paa højere Tal, saaat Indexen vil kunne skydes opad og registrere Toppens Stand. Instrumentets Tryk-Correction var mig opgivet af Hr. Buchanan. Den blev i 1878 bestemt af mig paa Expeditionen, som nedenfor nærmere omtalt.

I 1878 var jeg betydelig bedre udrustet med Dybvandsthermometre, saavel med Hensyn til Antal som Godhed, end de foregaaende Aar. Hos Casella anskaffedes tre Index-Thermometre, der, efter Hr. Buchanans Model, deri vare forskjellige fra de ældre Miller-Casella-Thermometre, at Graderne paa Minimumsiden vare betydelig længere (1° C = 6 mm.) og at der paa selve Thermometerrøret var indætset en Millimeterskala, der benyttedes til den egentlige Aflæsning, medens Gradskalaen ved Siden af Røret tjente til Control. Værdien af Millimeterskalaens Delstreger bestemtes ved Sammenligning med Normalthermometret. Middelfejlen af en enkelt Aflæsning var kun 0°.03 til 0°.04. Disse tre Thermometre "Casella-Buchanan" ere i det Følgende betegnede ved Tallene 46, 48 og 49.

Et stort Held var det, at jeg Vaaren 1878 gjennem en technisk Journal, som en for vor Expedition varmt interesseret Ven viste mig, blev bekjendt med Negretti & Zambra's nye Kviksølv-Dybvandsthermometer, der registrerer Temperaturen ved at Instrumentet vendes om og som, indesluttet i et sterkt Glasrør, er upaavirket af det ydre Tryk. En Beskrivelse af Instrumentet, i den Form, hvori vi brugte det (med Trækasse) findes i "Nature" for 25. Juli 1878. Af dette Instrument anvendtes to Stykker stadig i 1878. De ere i det Følgende betegnede ved Tallene 89 og 91.

[1] L. c. S. 163.

A variation in temperature of 1° C corresponds very nearly to 3 mm. on the scale. When lowered in the deep, the pressure of the sea-water acts on the instrument so as to compress alike the glass, the pure water in the tube, and the mercury. At a given temperature, the top of the mercury, C, will point to higher figures (a lower temperature) than in the atmosphere, the compressibility of water predominating. For every 100 fathoms of depth, the positive temperature-correction thus amounts to 0°.15, or 0.4 mm. on the scale. In the sea, where the temperature, as a rule, decreases with the depth, the reading of the lower end of the index, converted to temperature and corrected for the influence of pressure, gives the deep-sea temperature sought to be determined. For the rest, Mr. Buchanan has shown[1] that a mercury-piezometer of this construction can give a correct determination of temperature, even should the temperature increase with the depth at a slow rate. An increase of the temperature with depth of less than 0°.15 per 100 fathoms, will, as appears, with our instrument cause the top of the mercury, C, to indicate lower figures; but the effect of the pressure will be greater and raise it to higher figures, so that the index can be pushed up and register the height of the mercury. The pressure-correction of the instrument was given me by Mr. Buchanan. In 1878, I determined it myself on the Expedition, as stated more in detail below.

In 1878, I was much better provided with deep-sea thermometers, both as regards number and excellence, than the two previous years. From Mr. Casella had been procured three index-thermometers, which, on Mr. Buchanan's model, differed from the original Miller-Casella thermometers in the degrees on the minimum-side being considerably wider (1° C = 6 mm.), and also in having on the tube of the thermometer itself a millimetre-scale etched in, which was used for the final reading-off, whereas the scale of degrees, at the side of the tube, served the purpose of control. The value of the millimetre-scale's divisions was determined by comparison with the Standard-Thermometer. The mean error of a single reading amounted only from 0°.03 to 0°.04. These three "Casella-Buchanan" thermometers will be indicated by the figures 46, 48, and 49.

In the spring of 1878, I had a piece of singular good fortune, viz., to become acquainted, from a technical journal shown me by a friend who interested himself warmly in the Norwegian Expedition, with Negretti and Zambra's new mercury deep-sea thermometer, which registers the temperature by the instrument turning over, and which, enclosed within a strong glass tube, remains wholly uninfluenced by the outer pressure. A description of the instrument having the form in which we used it (with a wooden frame), will be found in "Nature" for 25 July 1878. Two of these instruments were in constant use during the cruise in 1878. They will be indicated by the figures 89 and 91.

[1] Ibid. p. 163.

Kobberhylstrene, hvori Index-Thermometrene vare indfattede, havde Tougstjerter i Ringene paa øvre og nedre Ende, ved Hjelp af hvilke de fastgjordes til Lodlinen. Negretti & Zambra's Vendethermometre (1878) havde en længere Stjert i den Ende, hvor Kuglen er, og Stjertens anden Ende fastgjordes til Lodlinen. I 1876 hang Miller-Casella-Thermometrene, naar de ikke vare i Brug, i Skorsten-Stagene foran denne. Gjennem en Luge i Dækket[1] strømmede varm Luft fra Kjedlens Overkant op og holdt Thermometrene stadig, naar Skibet var under Damp, paa en temmelig høj Temperatur. Dette var ganske hensigtsmæssigt, da Benyttelsen af Minimums-Indexen tilsiger, at Thermometret bør naa det Sted i Dybet, hvis Temperatur skal maales, med en højere Temperatur end Stedets. I 1877 og 1878 havde vi en Bestiklugar paa Hyttedækket.[2] Paa Agterkant af denne opsloges en Række, med Huller, i hvilke Dybvandsthermometrene anbragtes. Som man af Figuren i Capt. Willes Afhandling vil forstaa, holdt ogsaa paa denne Plads Thermometrene sig varme. I 1878 havde jeg Instrumenterne anbragt, naar de ikke brugtes, i Arbejdssalonen. For hvert Lodskud eller Temperaturrække satte jeg de til samme bestemte Thermometre op i Rækken paa Bestikhuset og indførte paa Forhaand deres Nummer i Loddejournalen ved de Dybder, til hvilke hvert af dem skulde benyttes. Da vi i 1878 arbejdede paa Dybet baade Dag og Nat uden Afbrydelse — Solen var altid over Horizonten — fandt jeg denne Ordning bekvem, navnlig for Operationerne om Natten. I Arbejdssalonen vedligeholdtes altid en almindelig Stue-Temperatur.

Dybvandsthermometrene sammenlignedes gjentagne Gange med et Normalthermometer under hver af Rejserne. I 1876 og 1877 foretoges disse Sammenligninger i en Pøs Vand paa Dækket efter gjentagen Omrøring med selve Instrumenterne. I 1878 brugte jeg en særskilt til dette Brug medtaget Comparator (Cylinderglas 20 cm. Diameter) med ringformet Rører, og foretog Sammenligningerne saavel paa Dæk som i Arbejdssalonen.

I 1876 blev, da jeg ikke havde Sne eller Is ombord, Thermometrenes Nulpunkter ikke bestemte. I 1877 bestemte jeg Thermometrenes Nulpunkter i Tromsø den 10. Juli i smeltende Sne. Den 23. Juli 1878 sammenlignedes, paa Beeren-Eiland-Banken, Thermometrene med Buchanans Kviksølvpiezometer ved en Temperatur af 0.°3, idet de i en Kurv vare nedfirede til 20 Favnes Dyb i Havet, altsaa en Comparation under nøjagtig de ved Observationerne stedfindende Forhold. Et lignende Experiment fore-

[1] Wille. Apparaterne og deres Brug. S. 3. *o* Fig. 2.

[2] Sammesteds. *h* Fig. 2.

The copper cases in which the index-thermometers were enclosed, had lanyards in the rings at the upper and the lower end, by means of which they were attached to the sounding-line. Negretti and Zambra's inverting-thermometers (1878) had a somewhat longer cord at the end where the bulb is placed, and the upper end of this cord was made fast to the sounding-line. In 1876, the Miller-Cassella thermometers, when not in use, hung suspended in the funnel-stays in front of the funnel. Through one of the hatchways[1] heated air from the upper surface of the boiler kept passing up, and gave the thermometers, when the vessel was under steam, a comparatively high temperature. This was very advantageous, since the use of the minimum-index assumes the thermometer reaching down to the place where the temperature has to be measured, with a higher temperature than prevails throughout that part of the deep. In 1877 and 1878, we had the deckhouse erected on the roundhouse.[2] On the afterpart of the former we put up a board perforated with holes, in which the deep-sea thermometers were placed. As will appear from the figure in Capt. Wille's Memoir, the thermometers got the requisite heat in this place too. On the cruise of 1878, the instruments, when not in use, were kept in the working-room. For every sounding or series of temperatures, I had the thermometers to be used put in the board on the deckhouse, entering beforehand the number of each in the sounding-journal along with the depths for which they severally were intended to be used. In 1878, working as we then did in the deep both day and night without cessation — the sun was constantly above the horizon — I found this arrangement very convenient, more particularly for the night-operations. In the working-room, a temperature equal to that prevailing in most sitting-apartments was always kept up.

The deep-sea thermometers I repeatedly compared with a standard-thermometer on each of the cruises. In 1876 and 1877, these comparisons were made in a bucket of water on the deck of the vessel, after repeated stirring with the instruments themselves. In 1878, I adopted for this purpose a specially-devised comparator (a cylindric glass, diameter 20 cm), with an annular-shaped stirrer, and made the comparisons both on deck and in the working-room.

In 1876, there being neither snow nor ice on board, the zero-points of the thermometers could not be determined. In 1877, I determined the zero-points of the several thermometers at Tromsø, on the 10th of July, in melting snow. On the 23rd of July 1878, the thermometers were compared, on the Beeren-Eiland Bank, with Buchanan's Mercury-Piezometer, at a temperature of 0°.3, being lowered in a basket to a depth of 20 fathoms, accordingly a mode of comparison under precisely the same con-

[1] Wille. The Apparatus and How Used, p. 3 *o*, fig. 2.

[2] Ibid. *h*, fig. 2.

tog jeg den 22. August 1878 i Advent Baj, Spidsbergen, i 15 Favnes Dyb ved 0°.9 og i Overfladen ved 4°.8. Den 29. November 1878 prøvedes samtlige Nulpunkter ved det meteorologiske Institut i Christiania i smeltende Sne. Denne og følgende Dag foretoges Sammenligninger ved højere Temperaturer mellem Dybvandsthermometrene og Normalthermometret.

Ved Indexthermometrene er jeg af Erfaring bragt til at gjøre følgende Bemerkninger. Ved de ældste Miller-Casella-Thermometre (I—IX) staar Skalaen med Gradinddelingen *ved Siden* af Thermometerrøret. Dette gjør Aflæsningen noget vanskelig, naar den yderste Nøjagtighed søges opnaaet. Gradskalaen var fæstet til Ebonitpladen med en Skrue i hver Ende. Man maa passe vel paa, at disse Skruer ikke ere løse, da der i dette Tilfælde kan opstaa en Usikkerhed ved alle Aflæsninger paa flere Tiendedele af en Grad. Ved Forsøg, anstillede paa disse Thermometre, medens de vare omgivne af smeltende Sne, fandt jeg den 29. November 1879, at der var en ganske liden Forskjel paa Aflæsningen, enten jeg aflæste den frie Kviksølvtop eller den til samme med Magneten nedtrukne Index. Denne viste sig at trykke Kviksølvtoppen flad, og gav saaledes en højere Temperatur. Correctionen beløb sig i Middel for sex Thermometre til + 0°.03 ± 0°.011. Ved de Aflæsninger, der ved Sammenligningerne med Normalthermometret eller ved Nulpunktbestemmelsen ere gjorte paa Kviksølvtoppen, er denne bleven corrigeret med + 0°.03 forat faa den Aflæsning, der svarer til Indexens nedre Ende. Det er de saaledes corrigerede Tal, som ere opførte i de følgende Tabeller.

En Ulejlighed ved Indexthermometrene er, at Kviksølvtraaden undertiden splitter sig. Dette kan i Regelen let rettes paa ved at svinge Instrumentet i en Slynge med Kuglen inderst. Centrifugalkraften driver da Kviksølvet sammen paa dets rette Plads. Undertiden sidder Indexen saa fast, at en Magnet ikke formaar at flytte den. I saadanne Tilfælder har jeg med Held brugt to eller tre Magneter, enten en paa hver Side af Røret — som det undertiden var nødvendigt at løsne fra Indfatningen — eller som magnetisk Magazin. Værre er det, naar Kviksølvet er kommet forbi Indexen og helt eller delvis indeslutter denne, thi da formaa Magneterne ikke at drage den ud deraf. I saadanne Tilfælder, naar Centrifugalkraftens Anvendelse ikke har forslaaet, har jeg med Held brugt den Fremgangsmaade at afkjøle Thermometerkuglen, undertiden ved Hjelp af fordunstende Æther. Kviksølvet — paa Minimumsiden, som jeg her altid har for Øje — trænger da ind i Kuglen eller den under samme værende Kaliberudvidelse, samler sig i dennes nederste Del med en mindre Højde og en større Diameter og lader Indexen saa fri, at den kan extraheres med Magnet. Ved den følgende

ditions as those under which the actual observations were made. On the 22nd of August 1878, I made a similar experiment in Advent Bay Spitzbergen, at a depth of 15 fathoms, temperature 0°.9, and at the surface of the sea, temperature 4°.8. On the 29th of November 1878, the zero-points of all the thermometers were tested at the Meteorological Institute in Christiania, by immersing the instruments in melting snow. On this and the following day, comparisons were undertaken at higher temperatures between the deep-sea thermometers and the Standard-Thermometer.

As to the index-thermometers, experience has led me to make the following remarks. The oldest Miller-Casella instruments (I—IX) have the graded scale *at the side* of the tube. This renders the reading somewhat difficult when great accuracy is sought to be attained. The scale was made fast to an ebonite plate by means of a screw at either end. Care must be taken lest these screws get loose; for if they do, an uncertainty to the extent of several tenths of a degree may arise in all the readings. When experimenting with these thermometers, on the 29th of November 1879, whilst they were immersed in melting snow, I found a very slight difference in the reading whether I read the free upper surface of the mercury or the index drawn down to the latter by the magnet. The index was found to press the surface of the mercury flat; and hence it indicated a higher temperature. The correction amounted in the mean for six thermometers to + 0°.03 ± 0°.011. When reading off the upper surface of the mercury — for comparisons with the Standard-Thermometer or determining zero-points — a correction of + 0°.03 has been applied, in order to obtain the reading that corresponds to the lower end of the index. The figures thus corrected are those given in the following Tables.

One inconvenience attaching to the index-thermometers, is that the thread of mercury will sometimes break. This can as a rule be easily rectified by swinging the instrument in a sling, with the bulb inwards. The centrifugal force will then force back the mercury into its right position. Occasionally the index gets jammed, so that one magnet is quite unable to move it. When such is the case, I have successfully made use of two or three magnets, either one on each side of the tube — which it sometimes proved necessary to loosen from the frame — or as a magnetic magazine. It is a matter of far greater perplexity when the mercury has passed the index and either wholly or in part surrounds the latter; for the magnet is then powerless to draw it out. In such cases — the application of centrifugal force being found insufficient — I have resorted with success to the following mode of procedure, viz., that of cooling the bulb of the thermometer, occasionally by means of evaporating ether. The mercury — that on the minimum-side, which is always to be understood — pushes through into the bulb or the expansion of the bore below it, and collects there in the lowest part with

Opvarmning trækker Kviksølvet sig tilbage i Røret, og man bringer med Magneten Indexen ned i dette. Efter en saadan Operation gjør man vel i at sammenligne Instrumentet med Normalthermometret.

En anden Ulempe ved Index-Thermometrene er følgende. Naar et eller flere saadanne benyttedes, sammen med Kviksølvpiezometret eller Negretti & Zambra's Vendethermometer, til Bestemmelse af Bundtemperaturen, eller som Led til Bestemmelsen af en Temperaturrække, fandt jeg undertiden, efterat have anbragt de behørige Correctioner ved de aflæste Temperaturer, at et af Indexthermometrene angav en Temperatur, der var merkelig forskjellig fra og højere end hvad de øvrige Thermometre angav. Naar jeg strax derpaa sammenlignede med Normalthermometret, fandt jeg, at vedkommende Thermometer havde forandret sin Correction og, naar den sidst fundne Correction anbragtes, var der i Regelen god Overensstemmelse med de andre Thermometre. De saaledes indtraadte Ændringer kunde beløbe sig til en hel og en halv Grad. Samtlige vore Indexthermometre, ældre og nyere, viste saadanne Uregelmæssigheder en eller flere Gange. Det mest paafaldende var imidlertid, at den pludselig indtraadte Forandring ikke varede mere end en, højst to Dage; efter den Tid gjenvandt Thermometrene sine tidligere havte Correctioner. Det synes, som om Aarsagen til Fænomenet nærmest skulde ligge deri, at den lille Udvidelse, som Thermometerrøret har lige under Kuglen, under et større Vandtryk i Dybet er bleven sammentrykket og derved har bevirket en højere Stand (Aflæsning) af Kviksølvtoppen, men at denne Virkning har tabt sig i Løbet af den følgende Dag under almindeligt Lufttryk, idet Glasset har gjenvundet sin oprindelige Ligevægtsform. Det har ikke lykkets mig at paavise ydre Omstændigheder, som i det enkelte Tilfælde skulde kunne forklare denne Virkning. Man maa derfor stadig være paa sin Post og have Control ved andre Thermometre. Det var først i 1877, at jeg blev opmerksom paa dette Fænomen. Det tør nok hænde, at flere af de i 1876 iagttagne Uregelmæssigheder havde en lignende Aarsag, navnlig ved Thermometer No. VII; men jeg har, ved at anvende skiftende Correctioner ved dette Instrument, dog ikke opnaaet nogen gjennemgaaende bedre Overensstemmelse end med faste Correctioner.

Negretti & Zambra's Vendethermometer, der er indesluttet i et ydre tilsmeltet Glasrør, som optager Vandtrykket, saaledes at dette ikke virker paa selve Thermometret, benyttedes af os i 1878 med den Vendemekanisme, som Fabrikanterne da havde givet det, nemlig en Trækasse med en Rende, hvori en Del Blyhagel kunde rulle og saaledes holde Tyngdepunktet til den ene Side. Under Udfiringen holdtes ved Lodlinens Fart Thermometerkuglen nederst. Ved Havbunden eller, ved Temperaturrækker, i en bestemt Dybde, standsede Bevægelsen, Thermometret gaves Tid til at antage det omgivende Vands Temperatur, og derpaa haledes

a less height and greater diameter, leaving the index sufficiently free to be extracted by the magnet. The subsequent heating causes the mercury to draw back within the tube, and the index is then brought down by means of the magnet into that part. After such an operation, it is advisable to compare the instrument with the Standard-Thermometer.

Another drawback attaching to the index-thermometers is the following. When one or more such were used, either along with the mercury-piezometer or Negretti and Zambra's inverting-thermometer, for measuring the bottom-temperature or as a link for determining serial temperatures, I sometimes found, after having applied the necessary corrections to the temperatures read off, that one of the index-thermometers indicated a temperature remarkably different from, and higher than, that indicated by the other thermometers. When, immediately after, I made a comparison with the Standard-Thermometer, I found the thermometer in question to have changed its correction, and, on applying the new correction, there was, as a rule, very fair agreement with the other thermometers. The changes thus occasioned might amount to a whole or half a degree. All our index-thermometers, both old and new, gave evidence of the same irregularity on one or several occasions. The most striking instance however, was that of this sudden change not having lasted more than one — at most two days; after that period the thermometers recovered their original corrections. It would seem as though the cause of the phenomenon lay principally in the expansion which the bore of the thermometer has directly under the bulb giving way when exposed in the deep to a greater pressure, thus occasioning a higher reading of the top of the mercury, but in such influence ceasing to operate during the course of the following day under ordinary atmospheric pressure, the glass having recovered its original form for equilibrium. I have not succeeded in finding the outward circumstances which in each case might explain this influence. Hence the observer must be constantly on his guard, and control the readings by means of other thermometers. It was not till 1877 this phenomenon attracted my attention. Very possibly, several of the irregularities observed in 1876 had a similar cause, in particular as regards thermometer No. VII; but I have nevertheless failed, by applying an interchange of corrections to this instrument, to attain better general agreement than with unchanged corrections.

Negretti and Zambra's inverting-thermometer, enclosed in an outer sealed glass tube, which resists the pressure of the water, in such manner that it does not act directly on the instrument, we used in 1878, with the inverting-mechanism which the maker had then devised, viz., a wooden frame containing a quantity of shot, free to move from end to end, and which kept the centre of gravity on one side. When veering out the instrument, the sounding-line pulls the bulb of the thermometer downmost. On the sea-bed, or, when taking serial temperatures, at a given depth, the motion ceased, the thermometer was given time to accomodate, and then

Linen ind, hvorved Thermometret vendtes, Kviksølvtraaden splittedes og registrerede Temperaturen, og Haglene rullede ned i den anden Ende, der nu blev den tungere, og tjente til at sikre Instrumentet mod en ny Omvending. Til sin Accomodation behøver dette Thermometer kun 3 Minuter, men det er en nødvendig Betingelse, at det i denne Tid staar lodret eller næsten lodret med Kuglen nedad. Dette finder Sted, naar Trækassen har Opdrift i Vandet. Denne Egenskab have Trækasserne, naar de ikke have været udsatte for sterkere Vandtryk. Men naar Trækasserne havde været paa større Dyb end et Par Hundrede Favne, viste Erfaring mig, at de mistede sin Flydeevne. Herom overbeviste jeg mig ved directe Forsøg. Naar en Trækasse kommer under et større Vandtryk, driver dette den i Træcellerne indesluttede Luft, der giver Træet dets Flydeevne, ud, og Kassen mister sin Opdrift. En saadan Kasse vil, naar Lodlinen standser, strax vende sig om og registrere Thermometrets Temperatur. Hvorvidt denne er den samme som det omgivende Vands, beror paa Omstændighederne. Dersom Temperaturen i Havets Dyb ikke forandrer sig eller kun forandrer sig ganske langsomt paa det Stykke, Thermometret gjennemløber i de sidste Minuter, vil dette kunne registrere den søgte Temperatur. Det er her at bemerke, at Accomodationen foregaar forholdsvis hurtig under Thermometrets nedadgaaende Bevægelse. Da det var umuligt at faa gjort nye Trækasser til hvert Dyblodskud, ere vore Bundtemperaturer, der væsentlig bero paa de Negretti-Zambra'ske Thermometre, bestemte efter det her fremsatte Princip og kunde derfor muligens være lidt for højt angivne. Der er imidlertid, som nedenfor skal vises, saa god Overensstemmelse mellem den ved Negretti & Zambra's Vendethermometre gjorte Bestemmelse af Trykcoefficienten for Buchanans Kviksølvpiezometer og den af Buchanan selv opgivne, at Virkningen af Forskjellen mellem begge paa 2000 Favnes Dyb ikke gaar op til mere end 0°.1, og Kviksølvpiezometret antyder endog en Correction i modsat Retning af den som ovenfor er antydet. En anden Control haves i de Bestemmelser af Indexthermometrenes Trykcorrectioner, der ere udførte i Dybet under den atlantiske Strøm, jevnførte med dem, der ere udførte i Polarstrømmen. I den første aftager Temperaturen raskere mod Dybet end i den sidste. De nævnte Bestemmelser ere gjorte med Negretti & Zambra's Vendethermometre som Normal, og give, som Resultat for 2000 Favnes Dyb, i Gjennemsnit —0°.31 for den varme Strøm og —0.°21 for Polarstrømmen. Dette peger i Retning af en mindre fuldstændig Accomodation i Polarstrømmen end i Dybet under den varme Strøm, et Forhold, der strider imod det virkelige, og saaledes kun tjener til at bestyrke Antagelsen af en fuldstændig Accomodation. Herom se yderligere nedenfor.

we hauled in the line, whereby the thermometer turned over, the thread of mercury broke and registered the temperature, and the shot rolled down to the other end, which now became the heavier, and thus kept the instrument from turning over again. For accomodation, this thermometer requires a space of 3 minutes; but it is a necessary condition that during this time the instrument shall keep perpendicular, with the bulb downwards. And such will not fail to be the case provided the wooden frame has the necessary buoyancy in the water. This property the frame is found to have, should it not have been exposed to any considerable pressure of water. But when the wooden cases had been lowered to some depth, for instance more than 200 fathoms, they lost their buoyancy. Of this I obtained proof by direct experiment. When one of such wooden cases has to sustain a great pressure of water, this expels the air in the pores of the wood, which gives the latter its buoyancy, and the case loses the property of floating. A frame in this condition will, on the stoppage of the sounding-line, immediately turn over and register the temperature of the thermometer. Meanwhile, whether it be the same as that of the surrounding water, depends upon circumstances. Provided the temperature in the depths of the sea do not vary, or vary but very slowly in the strata passed through by the thermometer during the last few minutes previous to stopping, the instrument will be able to register the temperature sought to be measured. I must remark here, that the accomodation proceeds quickly on the downward passage of the thermometer. As new wooden frames could not possibly be got ready for every deep-sea sounding, our bottom-temperatures, which ultimately depend on Negretti & Zambra's inverting-thermometers and are determined on the principle here laid down, may therefore, possibly, have been given a trifle too high. Yet there is, as will be shown farther on, such excellent agreement between the determination of the coefficient of pressure for Buchanan's mercury-piezometer computed from Negretti & Zambra's inverting-thermometers and that given by Buchanan himself, that the effect of the difference at a depth of 2000 fathoms does not amount to more than 0.°1; and the mercury-piezometer indicates even a correction of an opposite character to that suggested above. Another mode of control lies in the determinations of the index-thermometers' pressure-corrections — which are made in the deep under the Atlantic Current — as compared with those made in the Polar Current. In the former current, the temperature diminishes more rapidly with the depth than in the latter. The said determinations are performed with Negretti & Zambra's inverting-thermometer as standard, and give an average result, for a depth of 2000 fathoms, of —0.°31 for the Warm Current and of —0°.21 for the Polar Current. This points towards a less perfect accomodation in the Polar Current than in the depths beneath the Warm Current — in direct opposition to fact, which thus tends to confirm our assuming a perfect accomodation. — Respecting this subject, see further on.

Ganske anderledes stiller Forholdet sig, naar Temperaturen stiger raskt med Dybet. En vastrukken Trækasse kan da komme til at lade Thermometret registrere ganske fejlagtige Temperaturer. Et slaaende Exempel herpaa havde vi paa Station No. 375. I 170 Favnes Dyb gav Kviksølvpiezometret en Temperatur af 2°.40. Ved Bunden, i 204 Favnes Dyb, altsaa kun 34 Favne dybere, gav Kviksølvpiezometret — 0°.51 og Miller-Casella No. I — 0°.33, begge reducerede for Skalafejl og for Tryk. Vendethermometret Negretti & Zambra No. 89 registrerede +. 0°.49, altsaa næsten en hel Grad for højt. Lignende Forhold vise Stationerne No. 327, 328 og 338. Allerede i de første Dage af vor Rejse i Østhavet blev jeg opmerksom paa disse Uregelmæssigheder, og lod derfor altid et Indexthermometer følge med et Vendethermometer ved Lodskuddene. Eftersom Trækasserne ved gjentagen Brug bleve vastrukne, lod jeg Tømmermanden gjøre nye Kasser, der benyttedes til de mindre Dybder, saalænge de, efter anstillet Forsøg i Havvand, bevarede sin Flydeevne. De vastrukne Kasser brugtes kun paa større Dyb. Det er ikke muligt ved Maling eller Fernissering at beskytte Trækasserne saaledes, at de hindres fra at tabe sin Flydeevne. Heller ikke er det muligt at gjengive vastrukne Kasser denne ved at tørre dem og give dem noget Overdrag. Paabundne Korkstykker kunne hjelpe, men kun for en Tid. Sterke tilsmeltede Glasrør, indsatte i Kassen, kunde raade Bod paa disse Ulemper. Nu for Tiden vil man dog foretrække de senere i Brug komne Vendemekanismer, ved hvilke Vendingen besørges under Begyndelsen af Ophalingen af en Skruepropeller, og det vendte Thermometer ikke senere faar Anledning til at vende sig om igjen. Dette sidste er af Vigtighed ved Temperaturrækker, naar man har flere Thermometre paa Lodlinen i forskjellige Dybder, og der er nogen Søgang. Under saadanne Omstændigheder kan man, naar man bruger Trækasser, frygte for, at et Vendethermometer, der allerede har registreret sin Temperatur, vender sig om igjen paa et højere Trin, idet Fartøjet sænker sig i Søen.

For at finde den Tid, de forskjelligartede Dybvandsthermometre behøve for at antage det omgivende Vands Temperatur, gjorde jeg en Række Forsøg. Thermometret stilledes i Vand eller en Blanding af Sne og Vand, efter først at være bleven bragt paa en højere Temperatur. Et Normalthermometer angav Vandets Temperatur. Begge Thermometre stode rolige i Vandet, og dette rørtes ikke om. Til visse Mellemrum aflæstes Dybvandsthermometret og samtidig dermed af en Assistent Tiden efter et Sekundur; umiddelbart ovenpaa aflæstes Normalthermometret. For hver Aflæsning beregnedes Forskjellen mellem begge Thermometres Udvisende. Hermed fortsattes, indtil at denne Forskjel var bleven constant. Med Argument: Aflæste Tidsminuter og Sekunder og Ordinater: Beregnet Forskjel mellem Thermometeraflæsningerne opconstru-

The case is very different when the temperature increases rapidly with the depth. A water-soaked wooden frame can then cause the thermometer to register utterly erroneous temperatures. We had a striking example of this fact at Station No. 375. At a depth of 170 fathoms the mercury-piezometer indicated a temperature of 2°.40. At the bottom, in a depth of 204 fathoms, accordingly not more than 34 fathoms deeper, the mercury-piezometer indicated —0°.51 and the Miller-Casella No. I —0°.33, after reducing both instruments for error of scale and for pressure. The inverting-thermometer, Negretti and Zambra No. 89, registered + 0°.49, or almost a whole degree too high. The same phenomenon was observed at Stations 327, 328, and 338. As early as the first days of our cruise in the Barents Sea, these irregularities attracted my attention, and therefore I had an index-thermometer invariably sent down with Negretti & Zambra's instrument. No sooner had the wooden cases got soaked through with water than I ordered the carpenter to make new ones, which were used for the minor depths, so long as, after careful testing in sea-water, they had been found to retain their buoyancy. The water-soaked cases were made use of for greater depths only. It is not possible by means of paint or varnish to protect the wooden cases, and thus prevent them from losing their buoyancy. Nor is it possible to restore buoyancy to the water-soaked cases by drying or giving them a covering of some kind or other. Pieces of cork are of use, but only for a time. Strong glass tubes, sealed at the ends, may serve, when put in the cases, to counteract these drawbacks. At present, however, preference will generally be given some one of the various kinds of inverting-mechanism, recently devised, which cause the instrument to turn over on hauling in the line, by means of a propelling screw, and then prevent it from turning back again. This is a matter of importance with series of temperatures, if several thermometers are attached to the sounding-line at different depths and a sea is running. Under such circumstances there is danger, with the wooden cases, of an inverting-thermometer that has already registered the temperature turning over again, on a higher level, when the vessel dips in the sea.

To find how long a time the various kinds of deep-sea thermometers require to take the temperature of the surrounding water, I instituted a series of experiments. The thermometer to be tested was placed either in water or a mixture of snow and water, after having first been given a higher temperature. A standard-thermometer indicated the temperature of the water. Both thermometers were allowed to remain undisturbed in the fluid, which I did not stir. At given intervals the deep-sea thermometer was read off, an assistant noting simultaneously the time by a watch, and immediately after the standard-thermometer. For every reading, the difference was computed between the indications of the two thermometers. This operation I continued till the said difference proved to be constant. With argument: minutes

eredes en Kurve. Denne nærmer sig asymptotisk til at blive en ret Line parallel med Abscisseaxen. Det Punkt, fra hvilket af denne Parallelisme begyndte, afmerkedes og ligeledes det tilsvarende Tidspunkt efter Uret, ved hvilket altsaa den fuldkomne Accommodation kunde ansees for at være naaet. Fra Accomodationspunktet afsattes tilbage hele Grader, og de tilsvarende Tidspunkter efter Uret afmerkedes. Der toges Forskjellen mellem Tidspunktet for den indtraadte Accomodation og disse Tidspunkter. Disse Tal udviste da, hvor lang Tid Dybvandsthermometret behøvede for at accommodere sig, naar dets Temperatur var 1°, 2°, 3°, o. s. v. forskjellig fra det omgivende Vands Temperatur. Jeg fik saaledes følgende Tabeller, i hvilke △ T betegner Temperaturforskjellen og △ t Tidsforskjellen i Minuter og Tiendedele deraf.

of time and seconds; and with ordinates: computed difference between readings of thermometers, I constructed a curve. This tends asymptotically towards a right line parallel to the axis of the abscissæ. The point from which this parallelism commences, was marked off, as also the corresponding point of time, by which therefore perfect accommodation may be assumed to have been attained. From the point of accommodation were set off, backwards, whole degrees, and the corresponding points of time marked off. The difference was taken between the point of time for the accomodation fully set in and the said points of time These figures indicated how long a time the deep-sea thermometer required to accomodate with its temperature different 1°, 2°, 3°, &c., from that of the surrounding water. I was consequently able to work out the following Tables, in which △ T denotes the difference in temperature and △ t the difference in time, computed in minutes and tenths of minutes.

Negretti & Zambra 89.		Kviksølvpiezometer. (*Mercury-Piezometer.*)		Casella-Buchanan 49.	
△T	△t m.	△T	△t m.	△T	△t m.
1°	2.5	1°	7.7	1°	5.4
2	2.7	2	9.0	2	6.3
3	2.8	3	9.7	3	6.9
4	2.85	4	10.1	4	7.5
5	2.87	5	10.3	5	7.9
„	„	6	10.5	6	8.2
„	„	7	10.6	7	8.5
„	„	8	10.7	8	8.7
„	„	9	10.8	9	9.0
„	„	10	10.8	10	9.2
„	„	11	10.9		
„	„	12	10.95		
„	„	13	11.0		
14	3.0	14	11.0		

Efter disse Undersøgelser lod jeg Indexthermometrene ikke hale ind, førend de havde været 10 Minuter i Vandet, og Vendethermometrene 3 Minuter. Under Thermometrenes Bevægelse med Loddet ned igjennem Vandet vil Strømningen bevirke en meget raskere Accomodation end Tilfældet var under Forsøgene, i hvilke Thermometrene stode stille i Vandet. Den Tid, som blev givet Dybvandsthermometrene til at accommodere sig, var saaledes altid fuldkommen betryggende.

Jeg gaar nu over til at redegjøre for de enkelte Dybvandsthermometres Correctioner.

After these investigations, the index-thermometers were not hauled in till they had been 10 minutes in the water, nor the inverting-thermometers till they had been 3. On the downward-passage of the thermometer with the lead through the water, the current will occasion a much more rapid accomodation than was the case with the experiments during which the thermometers remained stationary in the water. Hence, the time given the deep-sea thermometers to accomodate was always amply sufficient.

I shall now pass on and explain the corrections for the several deep-sea thermometers.

Miller-Casella No. I.

Nulpunkt-Correction.

1877.	Juli 10.	+ 0.°17	Tromsø.
1878.	Maj 8.	+ 0 .07	Christiania.
„	Juli 23.	+ 0 .13	ved Beeren Eiland.
„	Nov. 29.	+ 0 .05	Christiania.
Middel		+ 0°.105	

Miller-Casella No. I.

Zero-Correction.

1877.	July 10.	+ 0°.17	Tromsø.
1878.	May 8.	+ 0 .07	Christiania.
„	July 23.	+ 0 .13	off Beeren Eiland.
„	Nov. 29.	+ 0 .05	Christiania.
Mean		+ 0°.105	

Den gjennemsnitlige Afvigelse af en enkelt Bestemmelse fra Medium bliver $= \pm 0^0.045$ (= MF).

I den følgende Tabel er opført Resultatet af samtlige Sammenligninger med Normalthermometret. Den paa Dybvandsthermometret aflæste Temperatur er betegnet ved t og den fundne Afvigelse fra (Correction til) Normalthermometret ved C. Ved Beregningen af denne er Correctionen reduceret til Aflæsningen af Indexen.

The average deviation of a single determination from the mean $= \pm 0^0.045$ (= MF).

In the following Table, I have given the result of all the comparisons with the Standard-Thermometer. The temperature read off on the deep-sea thermometer is indicated by t, and the difference from (correction to) the Standard-Thermometer, by C. When computing the difference, the correction was reduced to the reading of the index.

No.	Datum. (*Date.*)		Sted. (*Locality.*)	t	C	B	C-B
1	1877.	Juni 12.	Stavanger.	9.°8	+ 0.°12	+ 0°.04	+ 0°.08
2	„	Juli 10.	Tromsø.	— 0. 2	+ 0. 17	11	+ 6
3	„	„ „	„	4. 1	+ 0. 06	8	— 2
4	„	„ „	„	6. 5	+ 0. 11	6	+ 5
5	„	Aug. 3.	Jan Mayen.	3. 7	+ 0. 04	8	— 4
6	„	„ 5.	I Søen (*At Sea*).	4. 9	— 0. 03	7	— 10
7	„	„ 6	„ „	7. 8	+ 0. 07	5	+ 2
8	„	„ 7.	„ „	9. 1	+ 0. 07	4	+ 3
9	„	„ 8.	„ „	10. 3	+ 0. 12	3	+ 9
10	„	„ 17.	Salten Fjord.	10. 7	— 0. 03	3	— 6
11	1878.	Maj 8.	Christiania.	— 0. 1	+ 0. 07	11	— 4
12	„	„ „	„	5. 7	— 0. 03	6	— 9
13	„	„ 9.	„	8. 0	— 0. 03	5	— 8
14	„	„ „	„	10. 2	— 0. 03	3	— 6
15	„	Juli 5.	I Søen (*At Sea*).	9. 1	+ 0. 09	4	+ 5
16	„	„ 18.	„ „	3. 1	+ 0. 11	8	+ 3
17	„	„ 23.	„ „	0. 2	+ 0. 13	11	+ 2
18	„	Aug. 22.	Advent Baj.	4. 8	+ 0. 05	7	— 2
19	„	„ „	„ „	0. 8	+ 0. 07	10	— 3
20	„	Nov. 29.	Christiania.	0. 0	+ 0. 05	11	— 6
21	„	„ „	„	5. 5	+ 0. 06	7	— 1
22	„	„ „	„	11. 1	+ 0. 05	3	+ 2
23	„	„ 30.	„	1. 5	+ 0. 13	5	+ 8
24	„	„ „	„	2. 2	+ 0. 17	4	+ 13
				128°.8	+ 1°.59		1°.27
				0°.105 × 24 =	+ 2. 52		
					— 0°.93		

Kaldes Nulpunkt-Correctionen N, sætter jeg Thermometrets Skalacorrection ved t^0

$$C = N + \alpha t$$

hvor α er en Coefficient, der betegner Correctionens Variation for 1^0 Celsius. N antager jeg bestemt efter den første Tabel. For at finde den sandsynligste Værdi af α sætter jeg (Σ = Summationstegn)

$$\Sigma C = \Sigma N + \Sigma \alpha t.$$

Er Antallet af Ligninger (Sammenligninger) n, har man

$$\Sigma N = n. N$$

og faar saaledes $\Sigma C = n. N + \alpha \Sigma t$

hvoraf $$\alpha = \frac{\Sigma C - n. N}{\Sigma t.}$$

Now, supposing the zero-correction be termed N, the scale-correction I put at t^0

$$C = N + \alpha t,$$

in which α is a coefficient indicating the variation of the correction for 1^0 Celsius. I regard N as determined by the first Table. In order to find the most probable value of α, I put (Σ = Symbol of Summation)

$$\Sigma C = \Sigma N + \Sigma \alpha t.$$

Taking the number of the equations (comparisons) at n, we have

$$\Sigma N = n . N,$$

and thus get $\Sigma C = n . N + \alpha \Sigma t$;

hence $$\alpha = \frac{\Sigma C - n . N}{\Sigma t.}$$

For Thermometer No. I have vi Σ C = + 1.59, n. N = 0.105 × 24 = + 2.52 og Σ t = 128.8, hvoraf

$$\alpha = -\frac{0.93}{128.8} = -0.0072$$

Correctionsformelen for No. I for Skala bliver saaledes

$$C = +0^0.105 - 0.0072\,t.$$

De efter denne Formel beregnede Værdier af Correctionerne ere opførte i ovenstaaende Tabel under Rubrikken B. I den sidste Rubrik staar Forskjellen mellem den observerede og den beregnede Correction : C—B. Summen af C—B er, uden Hensyn paa Fortegn, 1.27, og den gjennemsnitlige Værdi, 1.27 : 24, er ± $0^0.053$.

De Miller-Casella'ske Dybvandsthermometre ere construerede saaledes, at Kuglen er beskyttet mod Sammentrykning ved Vandets Tryk. Men Thermometerrøret er udsat for Trykket, der gjør dets Kaliber mindre og driver Kviksølvtraaden bort fra Kuglen, hvorved Aflæsningen giver en for høj Temperatur. Paa Minimumsiden, hvor Indexen er nærmest Kuglen, bliver denne Virkning af Trykket ringe, men paa Maximumsiden bliver den merkelig stor, da Kviksølvtraaden, der kun er lidet sammentrykkelig, antager en forøget Længde i det indsnevrede Kaliber. De for Maximumsiden fra Casella opgivne Trykcorrectioner for vore Thermometre vare fra $0^0.6$ til $1^0.1$ for 2000 Favnes Vandtryk. Ved vore Undersøgelser benyttedes kun Minimumsiden. Correctionen for Trykket paa denne har jeg kunnet bestemme, i 1878, directe for hvert Indexthermometer ved Sammenligninger af de paa større Dyb gjorte Registreringer med, hvad de Negretti-Zambra'ske Vendethermometre udviste paa samme Sted og til samme Tid, idet de sidstes Registreringer ere ganske uafhængige af Trykket. Ved Lodskuddene paa større Dybder lod jeg et eller flere Indexthermometre ledsage til Bunds af et Vendethermometer og erholdt derved en Række Sammenligninger til Bestemmelse af Indexthermometrenes Trykcorrection. Ved Beregningen af denne kan Correctionens Størrelse uden merkelig Fejl sættes proportional med Dybden. Den skal, som ovenfor paavist, være negativ. I den følgende Tabel indeholder den første Rubrik Loddestationens Nummer, den anden Rubrik Dybden i engelske Favne, den tredie Rubrik Aflæsningerne af Minimumsindexen paa Thermometer No. I, corrigerede for Skalaens Feil efter den ovenfor givne Formel, den fjerde Rubrik Aflæsningerne af et af Negretti & Zambras Vendethermometre No. 89 eller No. 91, corrigerede for Skalafejl (se nedenfor), den femte Rubrik Forskjellen mellem Tallene i fjerde og tredie Rubrik eller Indexthermometrets Trykcorrection.

For Thermometer No. I, we have Σ C = + 1.59, n. N = 0.105 × 24 = + 2.52, and Σ t = 128.8; hence

$$\alpha = -\frac{0.93}{128.8} = -0.0072.$$

The formula of correction for No. I (scale) will accordingly be

$$C = +0^0.105 - 0.0072\,t.$$

The values computed for the corrections according to this formula have been given in the above Table, Column B. In the last column, the difference between the observed and the computed correction is C—B. The sum of C—B amounts, without reference to signs, to 1.27, and the average value, 1.27 : 24, is ± $0^0.053$.

The Miller-Casella deep-sea thermometers are so constructed as to have the bulb protected from the pressure of the water. But the tube of the instrument is exposed to such pressure, which reduces the bore and forces the thread of quicksilver away from the bulb, whereby the reading gives too high a temperature. On the minimum-side, where the index lies nearest the bulb, the effect of this pressure is but slight; but on the maximum-side it gets remarkably strong, since the thread of mercury, which is but very slightly compressible, assumes an increased length in the contracted bore. The pressure-corrections given by Casella for our thermometers on the maximum-side, were as high as $0^0.6$ to $1^0.1$ for the pressure at a depth of 2000 fathoms. With our investigations, the minimum-side only was used. The pressure-correction of this side I was able to determine direct, in 1878, for each index-thermometer, by comparing the registrings at great depths with the results exhibited by the Negretti & Zambra inverting-thermometers in the same spot and at the same time, the registrations of the latter instruments being wholly independent of pressure. With soundings undertaken at great depths, I sent down along with one or more of the index-thermometers an inverting-thermometer, and thus obtained a series of comparisons for determining the pressure-correction of the index-thermometers. When computing the latter, the correction may be put, without serious error, proportional to the depth. It should, as stated above, be negative. In the following Table, the first column contains the numbers of the Sounding-Stations, the second column, the depth in English fathoms, the third column, the reading of the minimum-index for Thermometer No. I, corrected for error of scale according to the formula given above, the fourth column, the reading of Negretti & Zambra's inverting-thermometer, No. 89 or 91, corrected for error of scale (see below), the fifth column, the difference between the figures in the fourth and third columns, or the pressure-correction of the index-thermometer.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. I.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O-B.
277	225	1°.10	0°.92	— 0°.18	— 0°.04	— 0°.14
294	637	— 1 .09	— 1 .25	— 0 .16	.12	— 4
296	1440	— 1 .09	— 1 .31	— 0 .22	.27	+ 5
303	1200	— 1 .38	— 1 .61	— 0 .23	.22	— 1
311	898	— 1 .09	— 1 .31	— 0 .22	.16	— 6
324	233	0 .90	0 .89	— 0 .01	.04	+ 3
332	1149	— 1 .38	— 1 .41	— 0 .03	.21	+ 18
342	523	— 0 .89	— 1 .05	— 0 .16	.10	— 6
343	743	— 0 .99	— 1 .25	— 0 .26	.13	— 13
344	1017	— 1 .09	— 1 .25	— 0 .16	.19	+ 3
354	1343	— 1 .09	— 1 .25	— 0 .16	.25	+ 9
355	948	— 1 .19	— 1 .31	— 0 .12	.17	+ 5
359	416	0 .85	0 .79	— 0 .06	.08	+ 2
360	421	0 .10	— 0 .03	— 0 .13	.08	— 5
367	535	— 0 .64	— 0 .74	— 0 .10	.10	0
368	315	1 .71	1 .61	— 0 .10	.06	— 4
	12043			— 2°.30	MF = ± 0°.061	

Kaldes Correctionen for Trykket c, Dybden i Favne h, sætter jeg

$$c = \beta\, h$$

og bestemmer den sandsynligste Værdi af Coefficienten β af Ligningen

$$\Sigma\, c = \Sigma\, \beta\, h = \beta\, \Sigma\, h, \qquad \beta = \frac{\Sigma\, c}{\Sigma\, h}.$$

For Thermometer No. I bliver altsaa

$$\beta = -\frac{2.30}{12043} = -0.000191 \text{ og } c = -0.000191\, h.$$

For 1000 Favne $c = -0^{\circ}.191$

„ 2000 „ $c = -0\,.382$

Man ser, at de enkelte observerede Correctionsværdier samtlige ere negative, saaledes som Forudsætningen er.

I den sjette Rubrik er opført de efter Formelen beregnede Trykcorrectioner, og i den sidste Rubrik Forskjellen mellem de observerede og beregnede Værdier. Af Summen af disse, uden Hensyn paa Fortegn, divideret med Observationernes Antal (16) findes den gjennemsnitlige Afvigelse for en enkelt Bestemmelse lig $\pm$ 0°.061. Denne indeslutter Fejlene i Indexthermometrets Aflæsning, i dets Nulpunktbestemmelse, i Skala-Correctionen, i Trykcorrectionen samt i Vendethermometrets Aflæsning og i dets Skalacorrection. Sættes disse sidste tilsammen til $\pm$ 0°.05, bliver den midlere Fejl af en enkelt fuldstændig reduceret Observation med Miller-Casella No. I kun $\pm$ 0°.03. Da imidlertid Vendethermometrene aflæses med samme Nøjagtighed som Miller-Casella's Indexthermometre, fremgaar som Resultat, at de forskjellige Correctioner ikke indføre nogen merkelig Usikkerhed i de reducerede Værdier for Temperaturen, og at Usikkerheden ene ligger i Aflæsningen. Dennes sandsynlige Fejl kan sættes til omkring $\pm$ 0°.05.

Now, assuming the correction for pressure to be termed c, the depth in fathoms h, I put

$$c = \beta\, h$$

and take the most probable value of the coefficient β from the equation

$$\Sigma\, c = \Sigma\, \beta\, h = \beta\, \Sigma\, h, \qquad \beta = \frac{\Sigma\, c}{\Sigma\, h}.$$

Hence, for Thermometer No. I,

$$\beta = -\frac{2.30}{12043} = -0.000191 \text{ and } c = -0.000191\, h.$$

For 1000 fathoms $c = -0^{\circ}.191$

„ 2000 „ $c = -0\,.382$

We perceive that each observed value of correction is invariably negative, as theory assumes.

In the sixth column are given the pressure-corrections computed from the formula, and in the last column, the difference between the observed and computed values. From the sum of these values, without reference to signs, divided by the number of observations (16), is found the average deviation of a single determination, which equals $\pm$ 0°.061. This result comprises the errors in the reading of the index-thermometer when determining the zero-point for that instrument, those in the scale-correction, the pressure-correction, as also those in the reading of the inverting-thermometer and in its scale-correction. Now, if we take the last of these together at $\pm$ 0°.05, the mean error of a single fully reduced observation with Miller-Casella No. I will amount to only $\pm$ 0°.03. Meanwhile, as the inverting-thermometers are read off with the same accuracy as the Miller-Casella index-thermometers, the result must be, that the various corrections do not occasion any sensible uncertainty in the reduced values for temperature, but that the uncertainty lies exclusively in the reading. The probable error of the latter may be put at about $\pm$ 0°.05.

Den samlede Correction for Miller-Casella No. I bliver saaledes

$$+ 0^{0}.105 - 0.0072\,t - 0.000191\,h.$$

Beregningen efter denne Formel har jeg udført ved Hjelp af to grafiske Tabeller, hvoraf den ene giver Værdien af Skala-Correctionen ($+ 0^{0}.105 - 0.0072\,t$) med Argument t, og den anden Værdien af Tryk-Correctionen ($0.000191\,h$) med Argumentet h.

Miller-Casella No. II.

Nulpunkt-Correction.

1877. Juli 10. $+ 0^{0}.02$ Tromsø
1878. „ 23. $+ 0.13$ ved Beeren Eiland.
„ Nov. 29. $+ 0.10$ Christiania.

Middel $+ 0^{0}.083$. $MF = \pm 0^{0}.042$.

Der synes fra 1877 til 1878 at være indtraadt en Forøgelse af Nulpunkt-Correctionen, fra $+ 0^{0}.02$ til $+ 0^{0}.115$. Imidlertid stemme Correctionsbestemmelserne fra 1876 meget godt overens med dem fra 1878, og Middel af C — B for 1877 bliver kun lidet forringet (fra $\pm 0^{0}.113$ til $\pm 0^{0}.097$) ved at benytte for dette Aar en særskilt Formel med Nulpunktcorrection $+ 0^{0}.02$. Jeg har derfor beregnet den hele Række Sammenligninger under et.

The total correction for Miller-Casella No. I will thus be

$$+ 0^{0}.105 - 0.0072\,t - 0.000191\,h.$$

The computation according to this formula, I made by means of two diagram-tables, one of which gives the value of the scale-correction ($+ 0^{0}.105 - 0.0072\,t$), with t as argument, and the other, the value of the pressure-correction ($0.000191\,h$), with h as argument.

Miller-Casella No. II.

Zero-Correction.

1877. July 10. $+ 0^{0}.02$ Tromsø.
1878. „ 23. $+ 0.13$ off Beeren Eiland.
„ Nov. 29. $+ 0.10$ Christiania.

Mean $+ 0^{0}.083$. $MF = \pm 0^{0}.042$

Between 1877 and 1878 there would seem to have set in an increase of the zero-correction, viz., from $+ 0^{0}.02$ to $+ 0^{0}.115$. Meanwhile, the determinations for correction in 1876 agree very well with those in 1878; and the mean of C — B for 1877 is but slightly diminished (from $\pm 0^{0}.113$ to $\pm 0^{0}.097$) by using for that year a special formula, with the zero-correction put at $+ 0^{0}.02$. Hence, I have calculated the whole series of comparisons in one.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1876. Juni 21.	I Søen (*At Sea*).	12°.2	+ 0°.37	+ 0°.28	+ 0°.09
2	„ 27.	„ „	11 .3	+ 0 .07	.27	— 20
3	Juli 17.	„ „	10 .7	+ 0 .32	.26	+ 6
4	„ 18.	„ „	9 .5	+ 0 .37	.24	+ 13
5	Aug. 5.	„ „	11 .9	+ 0 .32	.28	+ 4
6	„ 20.	„ „	11 .1	+ 0 .27	.27	0
7	1877. Juni 12.	Stavanger.	9 .9	+ 0 .02	.24	— 22
8	Juli 10.	Tromsø.	0 .0	+ 0 .02	.08	— 6
9	„ „	„	4 .2	— 0 .09	.15	— 24
10	„ „	„	6 .5	+ 0 .21	.19	+ 2
11	Aug. 5.	I Søen (*At Sea*).	4 .9	+ 0 .02	.16	— 14
12	„ 6.	„ „	7 .7	+ 0 .20	.21	— 1
13	„ 7.	„ „	9 .0	+ 0 .17	.23	— 6
14	„ 8.	„ „	10 .2	+ 0 .22	.25	— 3
15	„ 17.	Salten Fjord.	10 .2	+ 0 .47	.25	+ 22
16	1878. Juli 5.	I Søen (*At Sea*).	11 .0	+ 0 .02	.26	— 24
17	„ 18.	„ „	3 .0	+ 0 .21	.13	+ 8
18	„ 23.	„ „	0 .1	+ 0 .13	. 8	+ 5
19	Aug. 22.	Advent Baj.	4 .6	+ 0 .20	.16	+ 4
20	„ „	„ „	0 .8	+ 0 .12	. 9	+ 3
21	Nov. 29.	Christiania.	— 0 .1	+ 0 .10	. 8	+ 2
22	„ „	„	5 .2	+ 0 .35	.17	+ 18
23	„ „	„	10 .9	+ 0 .20	.26	— 6
24	„ 30.	„	1 .4	+ 0 .21	.10	+ 11
25	„ „	„	2 .2	+ 0 .23	.12	+ 11

$168^{0}.4 \quad + 4^{0}.73 \qquad MF = \pm 0^{0}.098.$

$0^{0}.083 \times 25 = + 2.07$

$+ 2^{0}.66 \qquad \alpha = + 0.0158$

$$C = + 0^{0}.083 + 0.0158\,t.$$

Af Sammenligningerne for 1877 faaes

$$\Sigma\, C = + 1^0.24$$
$$n\,.\,N = 9 \times 0^0.02 = + 0\,.18$$
$$\Sigma\, C - n\,.\,N = + 1\,.06 \qquad \Sigma\, t = 62\,.6 \qquad \alpha = + 0.0169$$
$$C = + 0^0.02 + 0.0169\ t. \qquad MF = \pm 0^0.097$$

For 1878 faaes

$$\Sigma\, C = + 1^0.77$$
$$n\,.\,N = 10 \times 0^0.115 = + 1\,.15$$
$$\Sigma\, C - n\,.\,N = + 0^0.62 \qquad \Sigma\, t = 39\,.1 \qquad \alpha = 0.0159$$
$$C = + 0^0.115 + 0.0159\ t. \qquad MF = \pm 0^0.092$$

For 1876 faaes Middel af C = + 0°.287. Middel af t = + 11°.12. For denne Temperatur giver Formelen for 1877: + 0°.208, Formelen for 1878: + 0°.292, og den fælles Formel: + 0°.259.

Da Thermometer No. II giver MF = ± 0°.098, er dette Thermometer ikke saa paalideligt som No. I.

Til Bestemmelsen af Trykcorrectionen haves følgende Iagttagelser.

From the comparisons for 1877, we have

$$\Sigma\, C = + 1^0.24$$
$$n\,.\,N = 9 \times 0^0.02 = + 0\,.18$$
$$\Sigma\, C - n\,.\,N = + 1\,.06 \qquad \Sigma\, t = 62\,.6 \qquad \alpha = + 0.0169$$
$$C = + 0^0.02 + 0.0169\ t. \qquad MF = \pm 0^0.097.$$

For 1878, we have

$$\Sigma\, C = + 1^0.77$$
$$n\,.\,N = 10 \times 0^0.115 = + 1\,.15$$
$$\Sigma\, C - n\,.\,N = + 0^0.62 \qquad \Sigma\, t = 39\,.1 \qquad \alpha = 0.0159$$
$$C = + 0^0.115 + 0\,.0159\ t. \qquad MF = \pm 0^0.092$$

For 1876, the mean of C = + 0°.287, the mean of t = + 11°.12. For this temperature, the formula for 1877 gives + 0°.208; the formula for 1878 + 0°.292; and the joint formula + 0°.259.

As Thermometer II gives MF = ± 0°.098, this instrument is not so trustworthy as No. I.

For determining the pressure-correction, I had the observations in the following Table.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. II.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O-B.
297	1280	− 1°.09	− 1°.41	− 0°.32	− 0°.23	− 0°.09
304	1735	− 1 .24	− 1 .46	− 0 .22	.31	+ 9
313	204	2 .42	2 .43	+ 0 .01	.04	+ 5
349	1487	− 1 .24	− 1 .46	− 0 .22	.27	+ 5
353	1333	− 1 .14	− 1 .46	− 0 .32	.24	− 8
	6039			− 1°.07	MF = ± 0°.072	

$$\beta = - 0.000177$$

For 1000 Favne c = − 0°.177
„ 2000 „ − 0 .354

Da MF af Trykcorrectionerne er mindre end MF af Skalacorrectionerne, ere aabenbart Aflæsningerne af No. II i 1878 sikkrere end det antydes af denne sidste.

Den samlede Correction for No. II bliver altsaa

$$+ 0^0.083 + 0.0158\ t - 0.000177\ h.$$

Miller-Casella No. III.

Nulpunkt-Correction.

1877. Juli	10.	+ 0°. 07	Tromsø.
1878. Juli	23.	+ 0 . 23	ved Beeren Eiland.
„ Nov.	29.	+ 0 . 18	Christiania.
Middel		+ 0°.160	MF = ± 0°.060.

Her er samme Bemerkning at gjøre som ved No. II.

$$\beta = - 0.000177$$

For 1000 fathoms c = − 0°.177
„ 2000 „ − 0 .354

The mean error of the pressure-corrections being less than the mean error of the scale-corrections, it is evident that the readings of Thermometer No. II in 1878 are more trustworthy than indicated by the last error.

The total correction for No. II is accordingly

$$+ 0^0.083 + 0.0158\ t - 0.000177\ h.$$

Miller-Casella No. III.

Zero-Correction.

1877. July	10.	+ 0°. 07	Tromsø.
1878. July	23.	+ 0 . 23	off Beeren Eiland.
„ Nov.	29.	+ 0 . 18	Christiania.
Mean		+ 0°.160	MF = ± 0°060.

Here the same remark is called for as with No. II.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1876. Juli 17.	I Søen (*At Sea*).	$10^0.7$	$+ 0^0.37$	$+ 0^0.25$	$+ 0^0.12$
2	„ 18.	„ „	9 .7	+ 0 .20	24	— 4
3	Aug. 5.	„ „	12 .0	+ 0 .27	26	+ 1
4	„ 20.	„ „	11 .2	+ 0 .20	25	— 5
5	1877. Juni 12.	Stavanger.	9 .8	+ 0 .13	24	— 11
6	Juli 10.	Tromsø.	— 0 .1	+ 0 .07	16	— 9
7	„ „	„	4 .3	— 0 .19	20	— 39
8	„ „	„	6 .6	+ 0 .01	22	— 21
9	Aug. 3.	Jan Mayen.	3 .8	+ 0 .32	18	+ 14
10	„ 5.	I Søen (*At Sea*).	5 .0	— 0 .18	20	— 38
11	„ 6.	„ „	7 .6	+ 0 .27	23	+ 4
12	„ 7.	„ „	8 .9	+ 0 .27	24	+ 3
13	„ 8.	„ „	10 .1	+ 0 .32	25	+ 7
14	„ 17.	Salten Fjord.	10 .3	+ 0 .37	25	+ 12
15	1878. Juli 1.	I Søen (*At Sea*).	4 .3	+ 0 .27	20	+ 7
16	„ 5.	„ „	8 .9	+ 0 .33	24	+ 9
17	„ 18.	„ „	2 .9	+ 0 .19	19	0
18	„ 23.	„ „	0 .2	+ 0 .23	16	+ 7
19	Aug. 22.	Advent Baj.	4 .5	+ 0 .30	20	+ 10
20	„ „	„ „	0. 6	+ 0 .25	17	+ 8
21	Nov. 29.	Christiania.	— 0. 2	+ 0 .18	16	+ 2
22	„ „	„	5. 4	+ 0 .19	21	— 2
23	„ „	„	11 .0	+ 0 .14	25	— 11
24	„ 30	„	1 .2	+ 0 .38	17	+ 21
25	„ „	„	2 .0	+ 0 .38	18	+ 20
			$150^0.7$	$+ 5^0.27$	MF = $\pm 0^0.110$	
		$0^0.160 \times 25 =$		+ 4 .00		
				$+ 1^0.27$	$\alpha = + 0 .0084$	

$$C = + 0^0.160 + 0.0084\ t.$$

Af Sammenligningerne for 1876 faaes Correction = $+ 0^0.26$ ved $10^0.9$. Efter Formelen faaes ved denne Temperatur $C = + 0^0.252$.

For 1877 alene faaes $C = + 0^0.07 + 0.0165\ t$.

$MF = \pm 0^0.130$.

For 1878 alene faaes $C = + 0^0.20 + 0.0157\ t$

$MF = \pm 0^0.080$

Til Bestemmelsen af Trykcorrectionen haves følgende Iagttagelser.

From the comparisons for 1876 we get the correction $= + 0^0.26$, at $10^0.9$. For this temperature, the formula gives $C = + 0^0.252$.

For 1877 alone, we have $C = + 0^0.07 + 0.0165\ t$.

$MF = \pm 0^0.130$.

For 1878 alone, we have $C = + 0^0.20 + 0.0157\ t$.

$MF \pm 0^0.080$.

For determining the pressure-correction, we have the following observations.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. III.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O-B.
285	1024	$— 1^0.32$	$— 1^0.25$	$+ 0^0.07$	$— 0^0.10$	$+ 0^0.17$
298	1500	— 1 .42	— 1 .46	— 0 .04	15	+ 11
305	1590	— 1 .37	— 1 .36	+ 0 .01	16	+ 17
312	658	— 1 .02	— 1 .36	— 0 .34	6	— 28
314	509	— 0 .56	— 0 .53	+ 0 .03	5	+ 8
315	180	2 .59	2 .43	— 0 .16	2	— 14
352	1686	— 1 .32	— 1 .46	— 0 .14	17	+ 3
362	459	— 0 .87	— 1 .05	— 0 .18	5	— 13
	7606			$— 0^0.75$	MF. = $\pm 0^0.138$	

$$\beta = - 0 .000099$$

For 1000 Favne $c = — 0^0.099$.

„ 2000 „ $— 0 .197$.

For 1000 fathoms $c = — 0^0.099$.

„ 2000 „ „ $= — 0 .197$.

Den forholdsvis store Værdi af MF tyder paa at Thermometer No. III ikke er saa paalideligt som de foregaaende. Den samlede Correction bliver

$$+ 0^0.160 + 0.0084\ t - 0.000099\ h.$$

The comparatively high value of the mean error would seem to indicate that Thermometer No. III is not so trustworthy as the foregoing instruments. The total correction will be

$$+ 0^0.160 + 0.0084\ t - 0.000099\ h.$$

Miller-Casella No. IV.

Nulpunkt-Correction.

1877.	Juli 10.	$+ 0^0.04$	Tromsø.
1878.	Juli 23.	$+ 0.08$	ved Beeren Eiland.
„	Nov. 29.	$+ 0.03$	Christiania.

Middel $+ 0^0.050$ MF $= \pm 0^0.020$.

Miller-Casella No. IV.

Zero-Correction.

1877.	July 10.	$+ 0^0.04$	Tromsø.
1878.	July 23.	$+ 0.08$	off Beeren Eiland.
„	Nov. 29.	$+ 0.03$	Christiania.

Mean $+ 0^0.050$ MF $= \pm 0^0.020$.

Skala-Correction. Scale-Correction.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1876. Juli 17.	I Søen *(At Sea)*.	$10^0.7$	$+ 0^0.37$	$+ 0^0.32$	$+ 0^0.05$
2	„ 18.	„ „	9 .5	+ 0 .37	29	+ 8
3	Aug. 5.	„ „	11 .9	+ 0 .35	35	0
4	„ 20.	„ „	11 .2	+ 0 .25	34	— 9
5	1877. Juni 12.	Stavanger.	9 .8	+ 0 .12	30	— 18
6	Juli 10.	Tromsø.	0 .0	+ 0. 04	5	— 1
7	„ „	„	4 .0	+ 0. 08	15	— 7
8	„ „	„	6 .3	+ 0. 31	21	+ 10
9	Aug. 6.	I Søen (*At Sea*).	7 .6	+ 0. 35	24	+ 11
10	„ 7.	„ „	8 .9	+ 0 .22	28	— 6
11	„ 8.	„ „	10 .0	+ 0 .42	30	+ 12
12	„ 17.	Salten Fjord.	10 .5	+ 0 .17	32	— 15
13	1878. Juli 5.	I Søen (*At Sea*).	8 .9	+ 0 .33	28	+ 5
14	„ „ 18.	„ „	3 .0	+ 0 .12	13	— 1
15	„ „ 23.	„ „	0 .2	+ 0 .08	5	+ 3
16	Aug. 22.	Advent Baj.	4 .6	+ 0 .20	17	+ 3
17	„ „	„ „	0 .7	+ 0 .17	7	+ 10
18	Nov. 29.	Christiania.	0 .0	+ 0 .03	5	— 2
19	„ „	„	5 .5	+ 0 .12	19	— 7
20	„ „	„	11 .0	+ 0 .11	33	— 22
21	„ 30.	„	1 .4	+ 0 .18	9	+ 9
22	„ „	„	2 .2	+ 0 .24	10	+ 14

$137^0.9 \quad + 4^0.63 \qquad$ MF. $= \pm 0^0.081.$

$0^0.050 \times 22 = + 1.10$

$+ 3^0.53 \qquad \alpha = + 0.0256.$

$$C = + 0^0.050 + 0.0256\ t.$$

For 1876 faaes Correction $= + 0^0.335$ ved $10^0.8$. Formelen giver $+ 0^0.326$. Thermometer No. IV har saaledes holdt sin Correction temmelig uforandret i alle tre Aar.

For 1876, we have the correction $= + 0^0.335$ for $10^0.8$. The formula gives $+ 0^0.326$. Thermometer No. IV has thus retained its original correction very nearly unchanged throughout the space of 3 years.

Tryk-Correction. | Pressure-Correction.

Station. No.	Dybde. (Depth.) Favne. (Fathoms.)	Therm. IV.	Therm. N & Z.	Obs. Corr.	Ber. (Comp.) Corr.	Diff. O-B.
299	1366	— 1°.49	— 1°.61	— 0°.12	— 0°.10	— 0°.02
306	1334	— 1 .23	— 1 .31	— 0 .08	— 0 .10	+ 0 .02
	2700			— 0°.20	MF = ± 0°.02	

$\beta = -0.000074$

For 1000 Favne c = — 0°.074.
„ 2000 „ — 0 .148.
Den samlede Correction for No. IV bliver
+ 0°.050 + 0.0256 t — 0.000074 h.

For 1000 fathoms c = — 0°.074.
For 2000 „ — 0 .148.
The total correction for No. IV is accordingly
+ 0°.050 + 0 .0256 t — 0°.000074 h.

Miller-Casella No. V.

Dette Thermometer benyttedes kun i 1876. Den 21. August dette Aar tabtes det, idet det under Lodning faldt ud af Hylsteret. Til Bestemmelse af dets Correctioner haves en Række Sammenligninger ombord med Normalthermometer og desuden samtidige Registreringer af Bundtemperaturen af No. V og et af de andre Miller-Casella- Thermometre, hvis Constanter senere bleve nøjagtigt bestemte.

Miller-Casella No. V.

This thermometer we used in 1876 alone. On August 21 of that year, the instrument was lost, having fallen out of the case on a sounding. For determining its corrections there are a series of comparisons taken on board with the Standard-Thermometer, as also registrings of the bottom-temperature with No. V and simultaneously with one of the other Miller-Cassella thermometers, the constants of which were afterwards accurately worked out.

No.	Datum. (Date.)	Sted. (Locality.)	t	C
1	1876. Juni 3.	Sognefjorden.	13 .8	+ 0°.07
2	„ 8.	„	9 .7	— 0 .03
3	„ 20.	I Søen (*At Sea*).	11 .3	— 0 .03
4	„ 27.	„ „	11 .7	— 0 .03
5	Juli 17.	„ „	10 .9	+ 0 .07
6	„ 18.	„ „	9 .8	+ 0 .07
7	Aug. 5.	„ „	11 .2	+ 0 .07

Station. No.	Dybde. (Depth.) Favne. (Fathoms.)	Therm. V Aflæst. (Read.)	Reduc. Therm.		Corr.
27	396	— 0°.30	VII	— 0°.27	+ 0°.03
30	401	— 0 .60	VII	— 0 .47	+ 0 .13
31	417	— 1 .20	VII	— 0 .96	+ 0 .24
32	11	11 .60	N Z	11 .80	+ 0 .20
32	31	9 .10	N Z	9 .10	0 .00
32	46	9 .00	N Z	8 .95	— 0 .05
51	515	— 0 .80	II	— 0 .42	+ 0 .38
52	1861	— 1 .15	III	— 1 .17	— 0 .02
53	1539	— 1 .25	IV	— 1 .29	— 0. 04
54	601	— 1 .35	III	— 1 .20	+ 0 .15

Indførte i Formelen: Correction $= N + \alpha t + \beta h$ give disse Observationer følgende Ligninger til at bestemme N, α og β:

Introduced into the formula:

Correction $= N + \alpha t + \beta h$,

these observations give the following equations for determining N, α, and β:

No.	N + t α + h β	=	Obs. Corr.	Ber. Corr. (*Comp.*)	O—B.
1	$N + 13.8\ \alpha + 0\ \beta$	=	+ 0°.07	0°.00	+ 0°.07
2	$N + 9.7\ \alpha + 0\ \beta$	=	— 0 .03	+ 0 .05	— 8
3	$N + 11.3\ \alpha + 0\ \beta$	=	— 0 .03	+ 0 .03	— 6
4	$N + 11.7\ \alpha + 0\ \beta$	=	— 0 .03	+ 0 .03	— 6
5	$N + 10.9\ \alpha + 0\ \beta$	=	+ 0 .07	+ 0 .04	+ 3
6	$N + 9.8\ \alpha + 0\ \beta$	=	+ 0 .07	+ 0 .05	+ 2
7	$N + 11.2\ \alpha + 0\ \beta$	=	+ 0 .07	+ 0 .03	+ 4
8	$N - 0.3\ \alpha + 396\ \beta$	=	+ 0 .03	+ 0 .12	— 9
9	$N - 0.6\ \alpha + 401\ \beta$	=	+ 0 .13	+ 0 .13	0
10	$N - 1.2\ \alpha + 417\ \beta$	=	+ 0 .24	+ 0 .14	+ 10
11	$N + 11.6\ \alpha + 11\ \beta$	=	+ 0 .20	+ 0 .03	+ 17
12	$N + 9.1\ \alpha + 31\ \beta$	=	0 .00	+ 0 .06	— 6
13	$N + 9.0\ \alpha + 46\ \beta$	=	— 0 .05	+ 0 .06	— 11
14	$N - 0.8\ \alpha + 515\ \beta$	=	+ 0 .38	+ 0 .12	+ 26
15	$N - 1.15\ \alpha + 1861\ \beta$	=	— 0 .02	— 0 .02	0
16	$N - 1.25\ \alpha + 1539\ \beta$	=	— 0 .04	+ 0 .01	— 5
17	$N - 1.35\ \alpha + 601\ \beta$	=	+ 0 .15	+ 0 .12	+ 3

Ved de mindste Kvadraters Methode findes
$N = +\ 0°.171$, $\alpha = -\ 0.01216$, $\beta = -\ 0.00011345$,
og altsaa Correction for No. V =

$+\ 0°.171 - 0.01216\ t - 0.000113\ h.$

De efter denne Formel beregnede Correctioner ere opførte under Rubrikken Ber. Corr. og Forskjellerne mellem de observerede og beregnede Correctioner i Rubrikken O—B. Af den sidste faaes MF $= \pm\ 0°.072$.

Som man ser, ere de enkelte Correctionsled af samme Orden som ved de øvrige Miller-Casella-Thermometre. De tre Sammenligninger med No. VII ere noget usikkre, da dette Thermometer (se nedenfor) i 1876 viste paafaldende Forandringer i Skalacorrectionen til forskjellige Tider. Til ovenstaaende Beregning har jeg for No. VII benyttet de Skalacorrectioner, der ere udledede af den Dagen før gjorte Sammenligning med Normalthermometret i Forbindelse med den til No. VII svarende Værdi af Coefficienten α.

By the method of the least squares we find
$N = +\ 0°.171$, $\alpha = -\ 0.01216$, $\beta = -\ 0.00011345$;
and hence the correction for No. V =

$+\ 0°.171 - 0.01216\ t - 0.000113\ h.$

The corrections computed according to this formula are given in the Column Corr. Comp., and the differences between the observed and computed corrections in Column O—B. From the latter we get MF $= \pm\ 0°.072$.

As will be seen, the several terms of correction are of the same order as for the other Miller-Casella thermometers. The three comparisons with No. VII are somewhat untrustworthy, that instrument (see below) having shown in 1876 striking changes in the scale-correction at various times. When making the above computation for No. VII, I used the scale-corrections found the day before from the comparison with the Standard-Thermometer, together with the value of the coefficient α corresponding to No. VII.

Miller-Casella No. VI.

Nulpunkt-Correction.

1877.	Juli 10.	+ 0°. 09	Tromsø.
1878.	Juli 23.	+ 0 . 13	Ved Beeren Eiland.
„	Nov. 29.	+ 0 . 14	Christiania.
	Middel	+ 0°.120	MF = ± 0°.020.

Miller-Casella No. VI.

Zero-Correction.

1877.	July 10.	+ 0°. 09	Tromsø.
1878.	July 23.	+ 0 . 13	off Beeren Eiland.
„	Nov. 29.	+ 0 . 14	Christiania.
	Mean	+ 0°.120	MF = ± 0°.020.

Skala-Correction. | Scale-Correction.

No.	Datum. (*Date.*)		Sted. (*Locality.*)	t	C	B	C -B
1	1876.	Aug. 20.	I Søen (*At Sea*).	11 .2	+ 0 .22	+ 0 .40	— 0 .18
2	1877.	Juni 12.	Stavanger.	9 .7	+ 0 .22	36	— 14
3		Juli 10.	Tromsø.	— 0 .1	+ 0 .09	12	— 3
4		„ „	„	4 .1	+ 0 .01	22	— 21
5		„ „	„	6 .2	+ 0 .41	28	+ 13
6		Aug. 3.	Jan Mayen.	3 .5	+ 0 .25	21	+ 4
7		„ 6.	I Søen (*At Sea*).	7 .7	+ 0 .22	31	— 9
8		„ 8.	„ „	10 .0	+ 0 .42	37	+ 5
9		„ 17.	Salten Fjord.	10 .2	+ 0 .47	38	+ 9
10	1878.	Juli 5.	I Søen (*At Sea*).	10 .7	+ 0 .25	39	— 14
11		„ 18.	„ „	2 .9	+ 0 .19	19	0
12		„ 23.	„ „	0 .2	+ 0 .13	12	+ 1
13		Aug. 22.	Advent Baj.	4 .4	+ 0 .37	23	+ 14
14		„ „	„ „	0 .7	+ 0 .17	14	+ 3
15		Nov. 29.	Christiania.	— 0 .1	+ 0 .14	12	+ 2
16		„ „	„	5 .2	+ 0 .33	25	+ 8
17		„ „	„	10 .8	+ 0 .29	39	— 10
18		„ 30.	„	1 .3	+ 0 .33	15	+ 18
19		„ „	„	2 .1	+ 0 .32	17	+ 15

$100^0.7 \quad + 4^0.83 \qquad MF = \pm 0^0.095$

$0^0.12 \times 19 = + 2 .28$

$+ 2^0.55 \qquad \alpha = + 0.0253$

$C = + 0^0.120 + 0.0253\ t.$

I 1876 synes Correctionen at have været noget mindre end senere, men nogen bestemt Slutning kan ikke gjøres af den ene Sammenligning. No. VI benyttedes meget faa Gange i 1876.

In 1876, the correction would appear to have been somewhat less than afterwards; but a definite result cannot be drawn from this one comparison. No. VI was seldom made use of in 1876.

Tryk-Correction. | Pressure-Correction.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. VI.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O -B.
301	1684	— $1^0.41$	— $1^0.51$	— $0^0.10$	— $0^0.19$	+ $0^0.09$
308	1136	— 1 .11	— 1 .36	0 .25	13	— 12
350	1686	— 1 .41	— 1 .56	0 .15	19	+ 4
351	1640	— 1 .31	— 1 .46	0 .15	18	+ 3
362	459	— 0 .96	— 1 .05	0 .09	05	— 4

6605 $\qquad - 0^0.74 \qquad MF = \pm 0^0.064$

$\beta = - 0 .000112$

For 1000 Favne $c = -0^0.112$.
" 2000 " $- 0.224$.
Den samlede Correction for No. VI bliver
$+ 0^0.120 + 0.0253\ t - 0.000112\ h$.

Miller-Casella No. VII.

Nulpunkt-Correction.

1877. Juli 10. $+ 0^0.17$ Tromsø.
1878. Juli 23. $+ 0.13$ Ved Beeren Eiland.
" Nov. 29. $+ 0.12$ Christiania.

Middel $+ 0^0.140$ MF $= \pm 0^0.020$.

Skala-Correction.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1876. Juni 21.	I Søen (*At Sea*).	12 .2	$+ 0^0.37$	$+ 0^0.20$	$+ 0^0.17$
2	" 27.	" "	11 .5	+ 0 .13	21	— 8
3	" 28.	" "	7 .6	+ 0 .10	24	— 14
4	Juli 11.	Thorshavn.	9 .1	+ 0 .27	23	+ 4
5	" 17.	I Søen (*At Sea*).	10 .5	+ 0 .52	54	— 2
6	" 18.	" "	9 .2	+ 0 .70	55	+ 15
7	Aug. 5.	" "	11 .7	+ 0 .53	53	0
8	" 20.	" "	11 .0	+ 0 .42	53	— 13
9	1877. Juni 12.	Stavanger.	10 .0	— 0 .08	5	— 13
10	" Juli 10.	Tromsø.	— 0 .2	+ 0 .17	14	— 3
11	" " "	"	4 .2	— 0 .09	10	— 19
12	" " "	"	6 .5	— 0 .16	8	— 24
13	" Aug. 3.	Jan Mayen.	3 .5	+ 0 .25	11	+ 14
14	" " 5.	I Søen (*At Sea*).	4 .9	+ 0 .04	10	— 6
15	" " 6.	" "	7 .7	+ 0 .12	7	+ 5
16	" " 7.	" "	9 .1	+ 0 .07	6	+ 1
17	" " 8	" "	10 .2	+ 0 .17	5	+ 12
18	" " 17.	Salten Fjord.	10 .5	+ 0 .17	5	+ 12
19	1878. Juli 5.	I Søen (*At Sea*).	11 .1	— 0 .11	4	— 15
20	" 18.	" "	3 .0	+ 0 .11	11	0
21	" 23.	" "	0 .2	+ 0 .13	14	— 1
22	Aug. 22.	Advent Baj.	4 .7	+ 0 .10	10	0
23	" "	" "	0 .7	+ 0 .17	13	+ 4
24	Nov. 29.	Christiania.	— 0 .1	+ 0 .12	14	— 2
25	" "	"	5 .4	+ 0 .16	9	+ 7
26	" "	"	11 .1	+ 0 .04	4	0
27	Nov. 30.	"	1 .3	+ 0 .26	13	+ 13
28	" "	"	2 .2	+ 0 .23	12	+ 11

Thermometer No. VII har i 1877 og 1878 holdt sine Correctioner godt. For disse to Aar faaes $\Sigma C - n . N = + 1^0.87 - 20 \times 0^0.14 = + 1^0.87 - 2^0.80 = - 0^0.93$, $\Sigma t = 106^0.0$ og $\alpha = - 0.0088$, MF $= \pm 0^0.081$ Altsaa $C = + 0^0.140 - 0.0088\ t$.

I 1876 derimod ere Correctionerne aabenbart foranderlige. For Tidsrummet 21. Juni til og med 11. Juli faaes i Medium Correctionen $+ 0^0.22$ for Tempe-

For 1000 fathoms $c = - 0^0.112$.
" 2000 " $- 0.224$.
The total correction for No. VI is accordingly —
$+ 0^0\ 120 + 0.0253\ t - 0.000112\ h$.

Miller-Casella No. VII.

Zero-Correction.

1877. July 10. $+ 0^0.17$ Tromsø.
1878. July 23. $+ 0.13$ off Beeren Eiland.
" Nov. 29. $+ 0.12$ Christiania.

Mean $+ 0^0.140$ MF $= \pm 0^0.020$.

Scale-Correction.

The thermometer No. VII had retained its corrections remarkably well in 1877 and 1878. For these two years we have $\Sigma C - n . N = + 1^0.87 - 20 \times 0^0.14 = + 1.^0 87 - 2^0.80 = - 0^0.93$, $\Sigma t = 106^0.0$ and $\alpha = - 0.0088$, MF $= \pm 0^0.081$.
Hence, $C = + 0^0.140 - 0.0088\ t$.

In 1876, on the other hand, the corrections are clearly variable. For the period, June 21 up to and including July 11, we have a mean correction of $+ 0.^0 22$

raturen $10^0.1$, hvilket, med den ovenfor fundne Værdi af α, der neppe kan antages at forandre sig med Tiden, giver en Nulpunkt-Correction af $+ 0^0.31$. For Tidsrummet fra 17. Juli til 20. August ere Correctionerne aabenbart større end før, i Medium $+ 0^0.54$ for Temperaturen $10^0.6$, hvilket giver en Nulpunktcorrection af $+ 0^0.64$. Jeg sætter derfor

for 21. Juni til 11. Juli $C = + 0^0.31 - 0.0088\ t$
og faar $MF = \pm 0^0.11$.

for 17. Juli til 20. August $C = + 0^0.64 - 0.0088\ t$
og faar $MF = \pm 0^0.07$.

Jeg har ogsaa beregnet Nulpunktcorrection af hver enkelt af de i 1876 gjorte Sammenligninger med Normalthermometret, sat disse Værdier op i Curve og derefter udregnet Correctionerne for de enkelte Aflæsninger paa No. VII fra Dybet. Se ovenfor under Miller-Casella No. V. Men der vandtes ingen gjennemgaaende større Nøjagtighed, efter de af andre samtidig anvendte Thermometres Angivelser. De med No. VII i den første Del af Rejsen i 1876 maalte Temperaturer staa saaledes tilbage for de øvrige i Nøjagtighed.

at the temperature $10^0.1$; and this, with the above determined value of α, which can hardly be supposed to vary with the time, gives a zero-correction of $+ 0^0.31$. For the period, July 17 to August 20, the corrections are evidently greater than before, the mean being $+ 0^0.54$ for the temperature $10^0.6$, which gives a zero-correction of $+ 0^0.64$. Accordingly, I put

for June 21 to July 11 $C = + 0^0.31 - 0^0.0088\ t$,
and get $MF = \pm 0^0.11$;

for July 17 to August 20 $C = + 0^0.64 - 0^0.0088\ t$,
and get $MF = \pm 0^0.07$.

I have also computed the zero-correction from each comparison made in 1876 with the Standard-Thermometer, drawn curves for these values, and then calculated the corrections for the several readings of No. VII in the deep sea (see above, Miller-Casella No. V). But no invariably greater accuracy was attained, judging from the indications of the other thermometers observed simultaneously. The temperatures measured with No. VII on the first part of the cruise in 1876 do not equal the others in accuracy.

Tryk-Correction. Pressure-Correction.

Station. No.	Dybde. (Depth.) Favne. (Fathoms.)	Therm. VII.	Therm. N & Z.	Obs. Corr.	Ber. (Comp.) Corr.	Diff. O-B.
309	1065	$- 1^0.15$	$- 1^0.31$	$- 0^0.16$	$- 0^0.11$	$- 0^0.05$
347	1429	$- 1\ .15$	$- 1\ .25$	$- 0\ .10$	$- 0\ .15$	$+ 0\ .05$
	2494			$- 0^0.26$		$MF = \pm 0^0.05$

$\beta = - 0.000104$.

For 1000 Favne $c = - 0^0.10$.
„ 2000 „ $- 0\ .21$.

Den samlede Correction for No. VII bliver saaledes:

for 1876 Juni 21 til Juli 11
$+ 0^0.31 - 0.0088\ t - 0.000104\ h$.
„ „ Juli 17 til Aug. 20
$+ 0^0.64 - 0.0088\ t - 0.000104\ h$.
„ 1877 og 1878 $+ 0^0.14 - 0.0088\ t - 0.000104\ h$.

For 1000 fathoms $c = - 0^0.10$.
„ 2000 „ $- 0\ .21$.

The total correction for No. VII is accordingly,

for 1876 June 21 to July 11,
$+ 0^0.31 - 0.0088\ t - 0.000104\ h$.
„ „ July 17 to Aug. 20
$+ 0^0.64 - 0.0088\ t - 0.000104\ h$.
„ 1877 & 1878 $+ 0^0.14 - 0.0088\ t - 0.000104\ h$.

Miller-Casella No. IX.

Nulpunkt-Correction.

1878. Juli 23. $- 0^0.17$ Ved Beeren Eiland.
„ Nov. 29. $- 0\ .11$ Christiania.

Middel $- 0^0.14$ $MF = \pm 0^0.03$.

Miller-Casella No. IX.

Zero-Correction.

1878. July 23. $- 0^0.17$ off Beeren Eiland.
„ Nov. 29. $- 0\ .11$ Christiania.

Mean $- 0^0.14$ $MF = \pm 0^0.03$.

Skala-Correction. Scale-Correction.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1878. Juli 5.	I Søen (*At Sea*).	$9^0.0$	$+ 0^0.18$	$+ 0^0.06$	$+ 0^0.12$
2	„ 18.	„ „	3 .2	+ 0 .08	— 7	+ 15
3	„ 23.	„ „	0 .5	— 0 .17	— 14	— 3
4	Aug. 22.	Advent Baj.	4 .8	+ 0 .05	— 3	+ 8
5	„ „	„ „	0 .9	— 0 .03	— 13	+ 10
6	Nov. 29.	Christiania.	0 .1	— 0 .11	— 15	— 4
7	„ „	„	5 .8	— 0 .18	— 1	— 17
8	„ „	„	11 .3	— 0 .14	+ 12	— 26

$35^0.\ 6 \quad - 0^0.32 \qquad \text{MF} = \pm\ 0^0.119$

$8 \times - 0^0.14 = - 1\ .12$

$+ 0^0.80 \qquad \alpha = + 0.0225$

$C = - 0^0.140 + 0.0225\ t.$

Tryk-Correction. Pressure-Correction.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. IX.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff O-B.
307	1216	$- 1^0.17$	$- 1^0.36$	$- 0^0.19$	$- 0^0.16$	$- 0^0.03$
310	1006	— 1 .27	— 1 .36	— 0 .09	— 0 .13	+ 0 .04
	2222			$- 0^0.28$		$\text{MF} = \pm\ 0^0.035$

$\beta = - 0.000126.$

for 1000 Favne $c = - 0^0.126$

„ 2000 „ $- 0\ .252.$

Den samlede Correction for No. IX bliver saaledes:

$- 0^0.14 + 0.0225\ t - 0.000126\ h.$

For 1000 fathoms $c = - 0^0.126.$

„ 2000 „ $- 0\ .252.$

The total correction is accordingly

$- 0^0.14 + 0.0225\ t - 0.000126\ h.$

Negretti & Zambra's Uformede Vendethermometer.

Før Afrejsen i 1877 fandtes i Christiania Nulpunktcorrectionen $= 0^0.0$. Den 29. Juni 1876 fandtes af 3 Observationer NZ $= + 9^0.93$ og No. V corrigeret $= + 9^0.95$. Herefter er det Uformede Vendethermometer antaget correct.

Negretti & Zambra's U-shaped Inverting-Thermometer.

Previous to our departure in 1877, the zero-correction was determined in Christiania $= 0^0.0$. On the 29th June 1876, NZ was found from 3 observations $= + 9^0.93$, and No. V corrected $= + 9^0.95$. Thence-forth the U-shaped inverting-thermometer was considered correct.

Buchanan's Kviksølv-Piezometer.

Nulpunktet fandtes den 10. Juli i Tromsø i smeltende Sne ved 225.2 mm.

Buchanan's Mercury-Piezometer.

Zero for this instrument was found July 10, at Tromsø, by immersion in melting snow at 225.2 mm.

Skala-Værdi. Scale-Value.

Datum. (*Date.*)	Sted. (*Locality.*)	Antal Obs.	Normalther. (*Stand.-Therm.*)	Buch. aflæst. (*read.*) a.	Piezom. beregn. (*comp.*) b.	Diff. a — b.	Temp. bereg. (*comp.*)	Diff. O - B.
				mm.	*mm.*	*mm.*		
1877. Juli 10.	Tromsø.	3	3°.32	214.93	215.24	— 0.31	3°42.	— 0°.10
„ „ „	„	1	6 .74	205.00	205.00	.00	6 .73	+ 1
Aug. 5.	I Søen (*At Sea*).	1	4 .90	210.60	210.50	+ .10	4 .87	+ 3
„ 17.	Salten Fjord.	1	10 .70	193.20	193.10	+ .10	10 .67	+ 3

25°.66 823.73 mm. MF = ± 0.128 mm. = ± 0°.042.

4 × 225.2 = 900.80

— 77.07 $\alpha = -3.0035$

$$t = \frac{225.2 - a}{3.0035}.$$

En Grad Celsius svarer til 3 mm. Til den praktiske Beregning construerede jeg en grafisk Tabel, der giver Temperaturen t med Argument Piezometeraflæsning a.

Hr. Buchanan havde opgivet Tryk-Correction for Kviksølvpiezometret til 0.417 mm. pr. 100 Favnes Vandtryk, og Værdien af en Grad til 3.02 mm. Dette svarer til en Trykcorrection af 1°.381 per 1000 Favne. Efterat jeg ved Sammenligningerne paa Dybet i 1878 mellem Negretti & Zambra's Vendethermometre og Miller-Casella-Thermometrene havde, som ovenfor vist, faaet bestemt de sidstes Tryk-Correctioner, kunde jeg benytte de paa samme Dyb gjorte samtidige Registreringer af Miller-Casella-Thermometrene og Kviksølvpiezometret til at verificere dettes Trykcorrection. Disse Registreringer staa i den følgende Tabel.

One degree Celsius corresponds to 3 mm. For practical computation, I constructed a diagrammatic table, in which the temperature, t, is given with the piezometer-reading, a, as argument.

Mr. Buchanan had given the pressure-correction for his Mercury-Piezometer at 0.417 mm. per 100 fathoms water-pressure, and the value of a degree at 3.02 mm. This corresponds to a pressure-correction of 1°.381 per 1000 fathoms. After having, on the cruise of 1878, by comparisons in the deep between Negretti & Zambra's inverting-thermometers and the Miller-Casella instruments, determined the pressure-corrections of the latter, I could use the registrings of the Miller-Casella thermometers and of the Mercury-Piezometer, made simultaneously at the same depth, to verify the pressure-correction of the latter. These registrings are given in the following Table.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. III. Corr.	Kv-piez. (*Merc-Piez.*) B.	Tryk-Corr. (*Pressure-Corr.*) for B.	Tryk-Corr. (*Pressure-Corr.*) ber. (*comp.*)	Diff. O - B.
96	805	— 1°.14	— 2°.26	+ 1°.12	+ 1°.13	— 0°.01
97	683	— 1 .13	— 2 .10	0 .97	0 .96	+ 1
98	388	— 0 .99	— 1 .52	0 .53	0 .55	— 2
129	709	— 1 .18	— 2 .10	0 .92	1 .00	— 8
171	642	— 1 .02	— 1 .78	0 .76	0 .90	— 14
176	536	— 0 .28	— 0 .94	0 .66	0 .75	— 9
179	1607	— 1 .17	— 3 .55	2 .38	2 .28	+ 10
184	1547	— 1 .21	— 3 .55	2 .34	2 .19	+ 15
213	1760	— 1 .19	— 3 .71	2 .52	2 .49	+ 3
218	968	— 1 .36	— 2 .66	1 .30	1 .36	— 6
219	796	— 1 .24	— 2 .28	1 .04	1 .12	— 8
	10441			14°.54		$\beta = + 0.001393$

Station. No.	Dybde. (Depth.) Favne. (Fathoms.)	Therm. IV. corr.	Kv-piez. (Merc-Piez.) B.	Tryk-Corr. (Pressure-Corr.) for B.	Tryk-Corr. (Pressure-Corr.) Ber. (Comp.)	Diff. O-B.
96	803	— 1°.09	— 2°.26	+ 1°.17	+ 1°.13	+ 0°.04
97	683	— 1 .13	— 2 .10	0 .97	0 .96	+ 1
98	388	— 1 .01	— 1 .52	0 .51	0 .55	— 4
129	709	— 1 .18	— 2 .10	0 .92	1 .00	— 8
179	1607	— 1 .20	— 3 .55	2 .35	2 .28	+ 7
180	1594	— 1 .20	— 3 .76	2 .56	2 .25	+ 31
184	1547	— 1 .19	— 3 .55	2 .36	2 .49	— 13
213	1760	— 1 .11	— 3 .71	2 .60	2 .49	+ 11
218	968	— 1 .35	— 2 .66	1 .31	1 .36	— 5
	10059			14°.75	$\beta = + 0.001466$	
		I.				
246	1592	— 1.38	— 3.60	+ 2.22	+ 2.25	— 0°.03
					$\beta = + 0.001394$	
		VII.				
246	1592	— 1.29	— 3.60	+ 2.31	+ 2.25	+ 0°.06
					$\beta = + 0.001451$	

Af samtlige Observationer faaes

$\beta = + 0.001428$

eller: Trykcorrection

for 1000 Favne = + 1°.428; for 2000 Favne = + 2°.856

Buchanans Opgave

+ 1 .381; 2 .762

Forskjel 0.°047 0°.094

Middel + 1 .405 2 .809

For 1877 har jeg reduceret Kviksølvpiezometrets Aflæsninger med en Trykcorrection af + 1°.405 per 1000 Favnes Tryk, efter en derefter construeret grafisk Tabel. Med denne faaes MF = ± 0°.078.

For 1877 bliver saaledes for Kviksølvpiezometret

$$t = \frac{225.2 - a}{3.0035} + 1.405 \frac{h}{1000}.$$

1878, Marts 8 blev Kviksølvpiezometret sammenlignet med Normalthermometret og dets Nulpunkt bestemt paa det meteorologiske Institut i Christiania. Hvert Tal beror paa 4 Observationer.

From the total number of observations we have

$\beta = + 0.001428$,

or: pressure-correction

for 1000 fathoms = + 1°.428; for 2000 fathoms = + 2°.856

Buchanan's Correction

+ 1 .381; 2 .762

Difference 0°.047 0°.094

Mean + 1 .405 2 .809

For 1877, I have reduced the readings of the Mercury-Piezometer, with a pressure-correction of + 1°.405 per 1000 fathoms, according to a diagram-table constructed for that purpose. With this, MF = ± 0°.078.

Hence, for 1877, the Mercury-Piezometer gives

$$t = \frac{225.2 - a}{3.0035} + 1.405 \frac{h}{1000}.$$

1878, March 8, the Mercury-Piezometer was compared with the Standard-Thermometer and its zero determined at the Meteorological Institute in Christiania. Each figure is based on 4 observations.

Normal (Standard) Therm.	Piezom. Obs. a.	Piezom. Ber. (Comp.)	Diff. O -B.	Temp. Ber. (Comp.)	Diff. O -B
	mm.	mm.	mm.	°	°
0°.00	224.50				
4 .95	209.90	209.96	— 0 .06	4 .97	— 0 .02
8 .60	199.25	199.24	+ 0 .01	8 .60	0 .00
12 .95	186.50	186.45	+ 0 .05	12 .93	+ 0 .02
26 .50	820.15 mm.		MF = ± 0 .04 mm.		MF = ±0°.013.
4 × 224.5 =	898.00				
	77.85		$\alpha = 2.938$		$t = \frac{224.5 - a}{2.938}$

Under Rejsen i 1878 verificeredes jevnlig Piezometrets Stand ved Sammenligning med Normalthermometret, og fandtes det altid uforandret.

Trykcorrectionen bestemtes i 1878 ved Sammenligning med de Negretti-Zambra'ske Vendethermometre.

On the cruise in 1878 the reading of the piezometer was regularly verified, by comparison with the Standard-Thermometer, and the instrument invariably found unchanged.

The pressure-correction was determined in 1878 by comparison with the Negretti & Zambra inverting-thermometers.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Piezom. Buch.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O-B.
263	121	$1^0.72$	$1^0.92$	$+ 0^0.20$	$+ 0^0.18$	$+ 0^0.02$
267	148	$- 1.60$	$- 1.46$	0.14	0.21	$-$ 7
268	130	$- 1.26$	$- 0.95$	0.31	0.19	$+$ 12
294	637	$- 2.24$	$- 1.25$	0.99	0.99	0*
298	1500	$- 3.78$	$- 1.46$	2.32	2.34	$-$ 2
303	1200	$- 3.40$	$- 1.61$	1.79	1.89	$-$ 10
306	1334	$- 3.46$	$- 1.31$	2.15	2.08	$+$ 7
310	1006	$- 2.97$	$- 1.36$	1.61	1.57	$+$ 4
314	509	$- 1.35$	$- 0.53$	0.82	0.80	$+$ 2
332	1149	$- 3.24$	$- 1.41$	1.83	1.80	$+$ 3
350	1686	$- 4.05$	$- 1.56$	2.49	2.62	$-$ 13
359	416	0.10	0.79	0.69	0.65	$+$ 4
	9836			$15^0.34$	MF $= \pm 0^0.055$	

$\beta = + 0.001560.$

Trykcorrection for 1000 Favne $= + 1^0.560$
„ 2000 „ $= + 3.120.$

Trykcorrectionen er saaledes for 1000 Favne $0^0.155$ større i 1878 end i 1877. For 1878 bliver for Kviksølvpiezometret.

$$t = \frac{224.5 - a}{2.938} + 1.560 \frac{h}{1000}.$$

Pressure-Correction for 1000 fathoms $= + 1^0.560.$
2000 „ $3.120.$

The pressure-correction for 1000 fathoms was accordingly greater by $0^0.155$ in 1878 than in 1877. For 1878 the Mercury-Piezometer has

$$t = \frac{224.5 - a}{2.938} + 1.560 \frac{h}{1000}.$$

Casella-Buchanan No. 46.

Den 8. og 9. Maj 1878 sammenlignedes Millimeter-Skalaen paa Minimumsiden med Normalthermometret paa det meteorologiske Institut i Christiania. I den følgende Tabel er t Temperaturen efter Normalthermometret, m Casella-Buchanan's Stand, begge som Media af flere Aflæsninger. Efter Formelen

$$m = m_0 + \alpha t + \beta t^2$$

beregnedes ved de mindste Kvadraters Methode Værdierne af Coefficienterne m_0, α og β. De efter Formelen med disse Værdier beregnede Værdier af m ere anførte i Tabellen under m. ber. og deres Forskjel fra de observerede under Rubrikken $\triangle$.

Casella-Buchanan No. 46.

On the 8th and 9th of May 1878, the millimetre-scale, on the minimum-side, was compared with the Standard-Thermometer, at the Meteorological Institute in Christiania. In the following Table t is the temperature, according to the Standard-Thermometer, m the reading of the Casella-Buchanan, both being the means from several readings. By the formula

$$m = m_0 + \alpha t + \beta t^2,$$

I computed by the method of the least squares the values of the coefficients m_0, α, and β. The values of m computed by the formula with these values are entered in the Table under m. comp.. and their difference from the observed in the Column $\triangle$.

t.	m. obs.	m. ber. (*comp.*)	△
	mm.	*mm.*	*mm.*
0°.00	14.40	14.26	+ 0.14
4 .97	46.00	46.55	— 0.55
8 .02	67.30	66.88	+ 0.42
10 .23	81.85	81.80	+ 0.05
15 .14	115.60	115.70	— 0.10

$$m = 14.26 + 6.398\ t + 0.01988\ t^2$$

Middel af △ = MF = ± 0.25 mm. = ± 0°.039.

Efter Formelen beregnedes en Tabel for de til hver Grad fra — 2 til + 5 svarende Værdier af m, og Resultatet opstilledes til praktisk Brug i grafisk Form.

Under Rejsen i 1878 sammenlignedes Casella-Buchanans Thermometre, oftere med Normalthermometret og fandtes altid uforandrede.

Mean of △ = MF = ± 0.25 mm. = ± 0°.039.

According to the formula, a table was computed for the values of m, corresponding to every degree from — 2 to + 5, and the result set down, for practical purposes, in a diagrammatical form.

On the cruise in 1878, the Casella-Buchanan thermometers were frequently compared with the Standard-Thermometer, and always found unchanged.

Tryk-Correction. Pressure-Correction.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. 46.	Therm. N & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff. O-B.
287	249	2°.96	2°.84	— 0°.12	— 0°.06	— 0°.06
297	1280	— 1 .07	— 1 .41	— 0 .34	31	— 3
305	1590	— 1 .15	— 1 .36	— 0 .21	39	+ 18
308	1136	— 1 .10	— 1 .36	— 0 .26	28	+ 2
313	204	2 .57	2 .45	— 0 .14	05	— 9
344	1017	— 1 .05	— 1 .25	— 0 .20	25	+ 5
352	1686	— 1 .05	— 1 .46	— 0 .41	41	0
353	1333	— 1 .08	— 1 .46	— 0 .38	33	— 5
367	535	— 0 .57	— 0 .74	— 0 .17	13	— 4
368	315	1 .68	1 .61	— 0 .07	08	+ 1
	9345			— 2°.30		MF = ± 0°.054

$$\beta = -\ 0\ .000246$$

For 1000 Favne c = — 0°.246
„ 2000 „ — 0 .492.

For 1000 fathoms c = — 0°.246.
„ 2000 „ — 0 .492.

Casella-Buchanan No. 48.

1878. Marts 8. og 9. | 1878. March 8th and 9th.

t.	m. obs.	m. ber. (*comp.*)	△
	mm.	mm.	mm.
$0^0.00$	36.0	35.90	+ 0.10
4 .97	65.2	65.51	— 0.31
8 .02	84.1	84.01	+ 0.09
10 .23	97.8	97.58	+ 0.22
15 .14	128.1	128.20	— 0.10

$$m = 35.90 + 5.890\ t + 0.013625\ t^2$$

$$MF = \pm\ 0.164\ mm. = \pm\ 0^0.028.$$

Tryk-Correction. Pressure-Correction.

Station. No.	Dybde. (*Depth.*) Favne. (*Fathoms.*)	Therm. 48.	Therm. N. & Z.	Obs. Corr.	Ber. (*Comp.*) Corr.	Diff.
294	637	— $1^0.00$	— $1^0.25$	— $0^0.25$	— $0^0.08$	— $0^0.17$
295	1110	— 1 .10	— 1 .36	— 0 .26	14	— 12
301	1684	— 1 .37	— 1 .51	— 0 .14	21	+ 7
307	1216	— 1 .19	— 1 .36	— 0 .17	15	— 2
311	898	— 1 .19	— 1 .31	— 0 .12	11	— 1
331	795	— 1 .20	— 1 .27	— 0 .07	10	+ 3
347	1429	— 1 .15	— 1 .25	— 0 .10	18	+ 8
351	1640	— 1 .37	— 1 .46	— 0 .09	21	+ 12
354	1343	— 1 .10	— 1 .25	— 0 .15	17	+ 2
	10752			— $1^0.35$	MF = ± $0^0.071$	

$$\beta = -\ 0.0001256.$$

For 1000 Favne c = — $0^0.126$
„ 2000 „ — 0 .251.

For 1000 fathoms c = — $0^0.126$.
„ 2000 „ — 0 .251.

Casella-Buchanan No. 49.

1879. Marts 8. og 9. | 1878. March 8th and 9th.

t.	m. obs.	m. ber. (*comp.*)	△
	mm.	mm.	mm.
$0^0.00$	17.00	16.90	+ 0.10
4 .97	48.00	48.41	— 0.41
8 .02	68.35	68.10	+ 0.25
10 .23	82.70	82.53	+ 0.17
15 .14	115.00	115.10	— 0.10

$$m = 16.90 + 6.27\ t + 0.0143\ t^2$$

$$MF = \pm\ 0.206\ mm. = \pm\ 0^0.033.$$

Tryk-Correction. | Pressure-Correction.

Station. No.	Dybde. (Depth.) Favne. (Fathoms.)	Therm. 49.	Therm. N & Z.	Obs. Corr.	Ber. (Comp.) Corr.	Diff.
284	800	— 1°.19	— 1°.25	— 0°.06	— 0°.09	+ 0°.03
296	1440	— 1 .23	— 1 .31	— 0 .08	15	+ 7
309	1065	— 1 .18	— 1 .31	— 0 .13	11	— 2
312	658	— 1 .18	— 1 .36	— 0 .18	7	— 11
333	748	— 1 .19	— 1 .36	— 0 .17	8	— 9
334	403	1 .00	0 .94	— 0 .06	4	— 2
349	1487	— 1 .45	— 1 .46	— 0 .01	16	+ 15
	6601			— 0°.69	MF = ± 0°.070	

$\beta = - 0.0001045$

For 1000 Favne c = — 0°.105
„ 2000 „ — 0 .209.

For 1000 fathoms c = — 0°.105.
„ 2000 „ — 0 .209.

Negretti & Zambra No. 89.

Nulpunkt-Correction.

1878. Maj 22. — 0°.22 Christiania.
1879. Jan. 6. — 0 .23 „

Middel — 0°.23 MF = ± 0°.01.

Negretti & Zambra No. 89.

Zero-Correction.

1878. May 22. — 0°.22 Christiania.
1879. Jan. 6. — 0 .23 „

Mean — 0°.23 MF = ± 0°.01.

Skala-Correction. | Scale-Correction.

No.	Datum. (Date.)	Sted. (Locality.)	t	C	B	C-B
1	1878. Maj 22.	Christiania.	0°.2	— 0°.22	— 0°.23	+ 0°.01
2	„ „ „	„	5 .0	— 0 .15	— 0 .11	— 4
3	„ „ „	„	9 .0	— 0 .10	— 0 .02	— 8
4	„ Juli 5.	I Søen (at Sea.)	9 .9	0 .00	0 .00	0
5	„ „ 18.	„ „ „	3 .5	— 0 .10	— 0 .15	+ 5
6	„ Aug. 22.	Advent Baj.	4 .9	— 0 .08	— 0 .12	+ 4
7	1879. Jan. 6.	Christiania.	9 .0	— 0 .02	— 0 .02	0
8	„ „ „	„	5 .1	— 0 .07	— 0 .11	+ 4
9	„ „ „	„	1 .3	— 0 .20	— 0 .20	0
10	„ „ „	„	0 .2	— 0 .23	— 0 .23	0
			48°.1	— 1°.17	MF = ± 0°.026	

— 0.23 × 10 = — 2 .30

+ 1°.13 $\alpha = + 0.0235$

C = — 0°.23 + 0.0235 t.

Tryk-Correction = 0. | Pressure-Correction = 0.

Negretti & Zambra No. 91.

Nulpunkt-Correction.

1878. Maj 22.	— 0°.10	Christiania.
1879. Jan. 6.	— 0 .19	„
Middel	— 0°.16	MF = ± 0°.040.

I Middelet er den sidste Nulpunktbestemmelse givet dobbelt Vægt, da den harmonerer bedst med de øvrige Correctionsbestemmelser.

Negretti & Zambra No. 91.

Zero-Correction.

1878. May 22	— 0°.10	Christiania.
1879. Jan. 6	— 0 .19	„
Mean	— 0°.16	MF = ± 0°.040.

In the mean, the last zero-determination has been given double weight, agreeing best, as it does, with the other corrective determinations.

Skala-Correction. Scale-Correction.

No.	Datum. (*Date.*)	Sted. (*Locality.*)	t	C	B	C-B
1	1878. Maj 22.	Christiania	0°.1	— 0°.10	— 0°.16	+ 0°.06
2	„ „ „	„	5 .0	— 0 .20	— 0 .13	— 7
3	„ „ „	„	9 .0	— 0 .20	— 0 .10	— 10
4	„ Juli 5.	I Søen (*At Sea*).	9 .9	— 0 .05	— 0 .09	+ 4
5	„ „ 18.	„ „	3 .5	— 0 .12	— 0 .14	+ 2
6	„ Aug. 22.	Advent Baj.	4 .9	— 0 .08	— 0 .13	+ 5
7	1879. Jan. 6.	Christiania.	9 .0	— 0 .06	— 0 .10	+ 4
8	„ „ „	„	5 .1	— 0 .10	— 0 .13	+ 3
9	„ „ „	„	1 .2	— 0 .17	— 0 .14	— 3
10	„ „ „	„	0 .2	— 0 .19	— 0 .16	— 3

$47^0.9 \qquad -1^0.27 \qquad \text{MF} = \pm 0^0.047.$

$-0^0.16 \times 10 = -1.60$

$+0^0.33 \qquad \alpha = +0.0069.$

$$C = -0^016 + 0.0069\ t.$$

Tryk-Correction = 0.

Pressure-Correction = 0.

Beregner man Værdien af Trykcorrectionen for 2000 Favne for Indexthermometrene særskilt for de Dele af Havet, der indtages af den varme atlantiske Strøm og af den kolde Polarstrøm, faar man følgende Resultat.

Calculating for the index-thermometers the value of the pressure-correction for 2000 fathoms separately for those parts of the ocean through which flow the warm Atlantic current and the cold Polar current, we get the following result.

Tryk-Correction for 2000 Favnes Dyb. Pressure-Correction for a Depth of 2000 Fathoms.

Thermometer.	Atlantisk Strøm. (*Atlantic Current.*)		Polarstrøm. (*Polar Current.*)		Anvendt. (*Applied.*)
Miller-Casella No. I.	— 0°.38	15 Obs.	— 0°.23	1 Obs.	— 0°.37
„ „ „ II.	— 0 .40	2	— 0 .34	3	— 0 .35
„ „ „ III.	— 0 .15	6	— 0 .12	2	— 0 .15
„ „ „ IV.	— 0 .12	1	— 0 .18	1	— 0 .15
„ „ „ VI.	— 0 .42	2	— 0 .16	3	— 0 .22
Casella-Buch. „ 46.	— 0 .49	8	— 0 .51	2	— 0 .49
„ „ „ 48.	— 0 .30	7	— 0 .14	2	— 0 .25
„ „ „ 49.	— 0 .21	6	— 0 .02	1	— 0 .21
Middel (*Mean*)	— 0°.31		— 0°.21		— 0°.27

I Polarstrømmen aftager Temperaturen langtsomst med Dybet. Her skulde Vendethermometrene, der tjene som Normaler for Bestemmelsen af Trykcorrectionerne, være bedst accommoderede, det er forholdsvis mest afkjølede, vise forholdsvis lavere, og følgelig Indexthermometrenes Trykcorrection vise sig større. Som man ser, er Trykcorrectionen i Polarstrømmen fundet numerisk mindre end i den varme Strøm. Man tør altsaa, som ovenfor Side 15 bemerket, antage, at Vendethermometrene have accommoderet sig fuldstændig efter Bundtemperaturen uagtet Kassernes tabte Flydeevne.

Den Nøjagtighed, med hvilken de for Skalafejl og Tryk reducerede Thermometeraflæsninger angive den rigtige Temperatur i Dybet, kan man faa en Forestilling om efter Størrelsen af Middelfejlen for Trykcorrectionens Bestemmelse ved de forskjellige Indexthermometre, da denne Bestemmelse indeslutter Skalacorrectionens Fejl. For Vendethermometrenes Vedkommende haves det samme Maal i Middelfejlen af Sammenligningerne med Normalthermometret. Opstilles de nævnte Værdier af Middelfejlen ved en enkelt Temperaturbestemmelse, faar man følgende Oversigt.

In the Polar current, the temperature diminishes most slowly with the depth. Here the inverting-thermometers serving as standards to determine the pressure-corrections, should prove best accomodated, i. e. comparatively most cooled, viz. read relatively lower, and hence the pressure-correction of the index-thermometers be greater. As will be seen, the pressure-correction in the Polar current was found numerically less than in the warm current. We may therefore assume, as previously remarked, p. 15, that the inverting-thermometers had become thoroughly accomodated in the bottom-temperature, notwithstanding the lost buoyancy of the frame.

The accuracy with which the thermometer-readings reduced for errors of scale and pressure, indicate the exact temperature in the deep strata, can be found by the magnitude of the mean error of the pressure-correction for the different index-thermometers, since that correction contains within it the error in the scale-correction. As regards the inverting-thermometers, we have the same standard in the mean error of the comparisons with the Standard-Thermometer. Now, if we put down the said values of the mean error of a single determination of temperature, the result will be as follows.

Thermometer.	MF.
Miller-Casella I.	$\pm$ 0°.061
" " II.	0 .072
" " III.	0 .139
" " IV.	0 .020
" " V.	0 .072
" " VI.	0 .064
" " VII.	0 .050
" " IX.	0 .035
Buch. Kv. (*Merc.*) Piezom.	0 .067
Casella-Buch. 46.	0 .054
" " 48.	0 .071
" " 49.	0 .070
Negr. & Zamb. 89.	0 .026
" " 91.	0 .047
Middel (*Mean*)	$\pm$ 0°.061

Middel for Indexthermometrene er $\pm$ 0°.064.
" " Vendethermometrene er $\pm$ 0 .037.

Da den sidste Værdi indgaar i Bestemmelsen af den første bliver Middelfejlen for en Temperaturbestemmelse med et Indexthermometer

$$\pm \sqrt{0.064^2 - 0.037^2} = \pm 0^0.052.$$

Ogsaa paa følgende Maade kan man bedømme Temperaturbestemmelsernes Nøjagtighed. I 1878 sendtes ofte 3 Dybvandsthermometre, 2 Index- og et Vendethermometer (i Regelen No. 89) med Loddet til Bunds. Tager man Middel af disse 3 Thermometres for Skalafejl og Tryk corrigerede Angivelser, og beregner Afvigelsen mellem de en-

Mean for the index-thermometers $\pm$ 0°.064.
" " inverting-thermometers $\pm$ 0 .037.

The last of these values being contained in the determination of the first, the mean error of a determination of temperature with an index-thermometer will be

$$\pm \sqrt{0.064^2 - 0.037^2} = \pm 0^0.052.$$

Also in another manner can the accuracy of the temperature-determinations be estimated. In 1878, 3 deep-sea thermometers, 2 index and 1 inverting-thermometer (as a rule No. 89), were sent to the bottom with the lead. Now, if we take the mean of the indications of these 3 thermometers, corrected for errors of scale and pressure,

kelte Thermometres Angivelser og dette Middel, faar man den følgende Tabel, der viser Gjennemsnits-Afvigelsen for hvert enkelt Thermometer:

and compute the deviation between the indications of the several thermometers and that mean, we get the following Table, which shows the average deviations for each thermometer:

No. I.	$\pm 0^{0}.041$	31 Observationer.
II.	44	5
III.	55	12
IV.	10	2
VI.	44	5
VII.	15	2
IX.	15	2
B.	43	17
46.	36	10
48.	33	12
49.	32	12
89.	42	56
91.	0 .037	4
Middel *(Mean)*	$\pm 0^{0}.040$;	170 Obs.

Efter denne Sammenstilling bliver saaledes Middelfejlen af en enkelt Temperaturbestemmelse i Dybet under $0^{0}.05$ i 1878. Da saavel i 1876 som i 1877 den samme Omhu er anvendt paa Aflæsningen af Thermometrene, idet denne altid foretoges af 2 Iagttagere, der confererede sine Noteringer, tør i Gjennemsnit vore Dybtemperaturer være sikkre paa en Tiendedel Grad Celsius. En lignende Beregning som for 1878 giver for 1877 Middelafvigelse fra Medium af 3 Observationer med 3 forskjellige Thermometre $\pm 0^{0}.034$ og for 1876 fra Medium af 2 Observationer $\pm 0^{0}.033$.

Ovenfor (Side 11) er paavist, at Buchanans Kviksølvpiezometer registrerer Temperaturen i Dybet rigtig, selv om denne skulde stige lidt med Dybden. De øvrige Indexthermometre derimod registrere rigtigt med Minimumsindexen kun under den Betingelse, at Temperaturen aftager med Dybden i et sterkere Forhold end Trykkets Virkning til at skyde Indexen nedover voxer med Dybden. At dette er Tilfældet i de større Dybder godtgjøres af følgende Tabel, i hvilken jeg har sammenstillet alle de Observationer, der kunne tjene til en nærmere Bestemmelse af Temperaturens Variation med Dybden i de dybere Lag.

According to this comparison, the mean error of a single determination of temperature in the deep was less than $0^{0}.05$ in 1878. As equal care was invariably taken both in 1876 and 1877 with the reading of the thermometers, this having in every case been done by 2 observers, who compared notes, our deep-sea temperatures may on an average be taken as correct within one-tenth of a degree centigrade. A computation similar to that for 1878 gives for 1877 the mean deviation from the mean of 3 observations with 3 different thermometers $\pm 0^{0}.034$, and for 1876 from the mean of 2 observations $\pm 0^{0}.033$.

It has been shown above (p. 11), that Buchanan's Mercury-Piezometer registers the temperature accurately in the deep strata, even should it rise slowly with the depth. The other index-thermometers, however, register correctly with the minimum-index solely in the event of the temperature diminishing with the depth in a proportion greater than that in which the force of the pressure exerted in pushing the index, increases with the depth. That such is the case in the great depths will be seen from the following Table, where I have set down all the observations that can serve for more closely determining the variation of temperature with depth in the deeper strata.

Aar. *(Year.)*	Lodskud No. *(Sounding, No.)*	Dybde Favne. *(Depth.)* *(Fathoms.)*	Therm. No.	Temperatur.	Dybde-Forskjel. *(Diff. of Depth.)*	Temp.-Forskjel. *(Diff. of Temp.)*	Temp.-Var. pr. 1000 Fv. *(Var. of Temp. for 1000 Fms.)*	Trykcorr. pr. 1000 Fv. *(Pressure-corr. for 1000 Fms.)*	Diff.
1876	40	1029	V	$-1^{0}.03$	186	$-0^{0}.17$	$-0^{0}.91$	$-0^{0}.11$	$-0^{0}.80$
		1215	V	-1 .20					
	51	721	III	-0 .94	205	-0 .16	-0 .78	-0 .07	-0 .71
		926	IV	-1 .10					
	51	926	IV	-1 .10	237	-0 .04	-0 .18	-0 .11	-0 .07
		1163	V	-1 .14					

Aar. (*Year.*)	Lodskud No. (*Sounding, No.*)	Dybde Favne. (*Depth.*) (*Fathoms.*)	Therm. No.	Temperatur.	Dybde-Forskjel. (*Diff. of Depth.*)	Temp.-Forskjel. (*Diff. of Temp.*)	Temp.-Var. pr. 1000 Fv. (*Var. of Temp. for 1000 Fms.*)	Trykcorr. pr. 1000 Fv. (*Pressure-Corr. for 1000 Fms.*)	Diff.
1877	183	800	VI	— 0°.79	200	— 0°.17	— 0°.85	— 0°.07	— 0°.78
		1000	IV	— 0 .96					
	183	1000	IV	— 0 .96	200	— 0 .11	— 0 .55	— 0 .10	— 0 .45
		1200	III	— 1 .07					
	183	1200	III	— 1 .07	200	— 0 .13	— 0 .65	— 0 .19	— 0 .46
		1400	I	— 1 .20					
	183	1400	I	— 1 .20	310	— 0 .07	— 0 .22	— 0 .09	— 0 .13
		1710	III. IV	— 1 .27					
	206	700	VII	— 0 .72	248	— 0 .29	— 1 .18	— 0 .11	— 1 .07
		948	VI	— 1 .01					
	206	948	VI	— 1 .01	300	— 0 .12	— 0 .40	— 0 .09	— 0 .31
		1248	III. IV	— 1 .13					
	217	629	I	— 1 .20	200	— 0 .09	— 0 .45	— 0 .09	— 0 .36
		829	III, IV	— 1 .29					
	243	1185	IV	— 1 .18	200	— 0 .09	— 0 .45	— 0 .15	— 0 .30
		1385	I. VII	— 1 .27					
1878	283	600	48	— 1°.09	167	— 0°.28	— 1°.70	— 0°.14	— 1°.56
		767	I. III	— 1 .37					
	307	1016	II	— 1 .13	200	— 0 .22	— 1 .10	— 0 .13	— 0 .97
		1216	48. IX	— 1 .35					
	308	836	IV	— 1 .04	300	— 0 .29	— 0 .97	— 0 .25	— 0 .72
		1136	46. VI	— 1 .33				— 0 .11	— 0 .86
	331	595	B	— 0 .98	200	— 0 .30	— 1 .50	— 0 .14	— 1 .36
		795	91. 48	— 1 .28					
	450	1385	I	— 1 .54	301	— 0 .04	— 0 .13	— 0 .11	— 0 .02
		1686	89. VI	— 1 .58					

I Lodskud No. 304 og 352 have Thermometrene angivet en Tilvæxt af Temperaturen i de dybeste Lag. Medens i disse Tilfælder Bundtemperaturen kan bestemmes med Nojagtighed, da tre Thermometre have fulgt med Loddet, maa jeg anse den i det næst højere Lag registrerede Temperatur for usikker, ved No. 304 paa Grund af at Thermometret No. 46 længere oppe i Temperaturrækken synes at have vist for hojt, ved No. 352 fordi No. 48 i andre Dybder stemme slet med andre Thermometres Registreringer.

Af ovenstaaende Tabel ser man, at samtlige de Iagttagelser, der kunne tjene som Bevis derfor, godtgjøre, at Temperaturen i store Dybder overalt har ladet sig registrere med Indexthermometrenes Minimumsindex. Tallene i den sidste Rubrik have samtlige negativt Fortegn: Temperaturaftagelsen er sterkere end Trykvirkningen.

I Sognefjorden er dette ikke Tilfældet, da Temperaturen ifølge Observationer med Negretti & Zambra's Vendethermometer, udførte i 1879 af Capt. Knap, Oplodningsdampskibet "Hansteen", er constant i de større Dyb over Bunden. Ved Stationerne 1, 2, 3, 4 og 5 er der derfor ikke anbragt nogen Correction for Trykket.

With soundings Nos. 304 and 352, the thermometers indicated an increase of temperature in the deepest strata. Whereas on these occasions the bottom-temperature could be accurately determined, 3 thermometers having accompanied the sounding-instrument, I must regard the temperature registered in 300 fathoms above the bottom as doubtful, with sounding No. 304, since the thermometer No. 46, farther up in the series of temperatures, would seem to have registered too high, and with No. 352, because No. 48 in other depths agreed very indifferently with the registrings of other thermometers.

From the above-given Table, we see that all observations calculated to serve as proof clearly show that the temperature in great depths could everywhere be registered with the minimum-index of the index-thermometers. The figures in the last Column have all negative signs — the diminution of temperature exceeds the effect of pressure.

In the Sognefjord this is not the case, the temperature — according to observations with Negretti & Zambra's inverting-thermometer, taken in 1879 by Capt. Knap from the Coast-Survey Steamer "Hansteen" — having proved constant in all the great depths. At Stations 1, 2, 3, 4, and 5 no correction has accordingly been applied for pressure.

I de øverste Vandlag hender det undertiden, at Temperaturen snart er aftagende, snart voxende med Dybden. I saadanne Tilfælder er det vanskeligt, ja tildels umuligt, at finde de rigtige Temperaturer med Indexthermometret. I Danmarkstrædet er Lieutenant Caroc kommet til gode Resultater ved Anvendelse af saavel Maximums- som Minimums-Indexen og en kritisk Anordning og Discussion af Iagttagelserne.[1]

En noget anden Fremgangsmaade har flere Gange givet mig ganske vel brugbare Resultater i saadanne Tilfælder, i hvilke Temperaturen først synker med Dybden og derpaa voxer. Den bestaar i at fire Thermometret ud saa varmt, at det naar de dybere Lag med et Temperaturoverskud over det omgivende Vand. Efter at have ladet Instrumentet accommodere sig, hvorved Minimumsindexen vil registrere den stedfindende Temperatur, haler man det op saa hurtigt som muligt. Instrumentets Træghed beskytter det mod en merkelig yderligere Afkjøling, medens det passerer mellemliggende koldere Lag. Aftager Temperaturen atter i en større Dybde, faar man de dybere Lags Temperatur meget godt registreret med Minimumsindexen. Saadanne Tilfælder forekomme jevnlig om Sommeren i den grønlandske Polarstrøm, paa de ydre Strøg, hvor den ikke fører Drivis. Temperaturen aftager fra Overfladen til en vis Dybde, f. Ex. 50 Favne, hvor den naar et Minimum, stiger derpaa til et secundært Maximum, f. Ex. i omtrent 100 Favnes Dybde, og aftager tilsidst stadig indtil Bunden. Det første Temperaturminimum faar man naturligvis nøjagtigt bestemt ved Minimumsindexen; det andet Maximum kan muligens blive noget afstumpet under Thermometrets Dvælen i de ovenforliggende koldere Lag, naar man, som sædvanligt, tager Temperaturrækken i en Sats med flere Thermometre paa forskjellige Steder af Lodlinen, der kræve lidt Tid for at løses fra denne; de dybere Lags Temperatur faar man derimod desto sikkrere bestemt, jo lavere Temperaturen selv er. Blive saaledes de mellemliggende relativ varmere Lags Temperatur muligens noget for lavt registrerede, saa faar man dog ved Temperaturrækken udtrykt den rigtige Karakter af Temperaturens Fordeling. Man sammenligne Temperaturrækkerne No. 297 og 298. (Pl. VI). Den første er taget udelukkende med Indexthermometre og giver følgende Maxima og Minima: Overfladen + 4°.4, 60 Favne: — 0°.8, 150 Favne: omtrent — 0°.2, 1280 Favne ved Bunden: — 1°.4. Den anden Række er taget udelukkende med Vendethermometret Negretti & Zambra No. 91, og giver: Overfladen: + 4°.0, 50 Favne: — 1°.2, 120 Favne: + 0°.04, 1500 Favne ved Bunden: — 1°.5.

I Fjordene paa Norges Vestkyst finder man undertiden om Sommeren, at Temperaturen først aftager fra

[1] Geografisk Tidskrift, udgivet af Bestyrelsen for det kongelige danske geografiske Selskab, 1878, S. 98.

In the uppermost strata it will sometimes happen that the temperature is now found to diminish, now to increase with the depth. In such cases it is difficult, nay well-nigh impossible, to find the right temperature with the index-thermometer. In Denmark Strait, Lieutenant Caroc attained excellent results by using both the maximum and minimum index, together with a critical arrangement and discussion of the observations.[1]

A somewhat different method has on several occasions procured me very fair results, viz, when the temperature first diminishes with the depth and then increases. It consists of lowering the thermometer sufficiently warm to admit of its reaching the lower strata with a temperature exceeding that of the surrounding water. After giving the instrument time to accomodate, when the minimum-index will register the existing temperature, the line is hauled in as quickly as possible. The sluggishness of the instrument guards against any further sensible cooling whilst passing through the intermediate colder strata. Should the temperature again decrease at a greater depth, you get the temperature of the deeper strata well registered by the minimum-index. Such cases are of frequent occurrence throughout the summer in the Greenland Polar current, viz., its outer tracts, where there is no drift-ice. The temperature diminishes from the surface to a certain depth, e. g. 50 fathoms, where it reaches a minimum, then increases to a secondary maximum, e. g. at a depth of about 100 fathoms, after which it steadily diminishes down to the bottom. The first minimum of temperature will of course be accurately determined by the minimum-index; the second maximum may possibly be somewhat reduced during the stoppage of the thermometer in the superincumbent colder strata, when, as is generally the case, serial temperatures are taken in one operation with several thermometers attached to different parts of the line, because a little time is required to detach the instruments; the temperature of the deeper strata on the other hand is determined with the greater accuracy the lower the temperature. Now, should, perhaps, the temperature of the intermediate and relatively warmer strata be registered a little too low, the whole series will nevertheless express the true character of the distribution of temperature. Compare the serial temperatures Nos. 297 and 298. (Pl. VI). The first was taken exclusively with the index-thermometers and gives the following Maxima and Minima: Surface + 4°.4; 60 fathoms — 0°.8; 150 fathoms about — 0°.2; 1280 fathoms (at the bottom) — 1°.4. The other series was taken exclusively with the inverting-thermometer, Negretti & Zambra No. 91, and gives: Surface + 4°.0; 50 fathoms — 1°.2; 120 fathoms + 0°.04; 1500 fathoms (at the bottom) — 1°.5.

In the fjords on the West Coast of Norway the temperature is sometimes found in summer first to diminish

[1] Geografisk Tidskrift, udgivet af Bestyrelsen for det kongelige danske geografiske Selskab, 1878, p. 98.

Overfladen nedad til et Minimum og derpaa stadig voxer indtil Bunden.

I disse Tilfælder forslaa ikke Indexthermometrene til at registrere de dybere Lags virkelige Temperatur. Station No. 148, i Vestfjorden udenfor Bodø, afgiver et udmerket Exempel herpaa, som følgende Tabel viser. De indklamrede Tal ere ikke anvendte til den endelige Bestemmelse af Temperaturen.

from the surface downwards to a minimum, and then steadily to increase to the bottom.

When such is the case, index-thermometers are not able to register the true temperature of the deeper strata. Station No. 148, in the Vestfjord, off Bodø, furnishes a good illustration of this, as may be seen from the following Table. The figures enclosed parenthetically were not made use of in the final determination of the temperature.

Dybde i Favne (*Depth in Fathoms*)	0	10	20	30	40	50	60	70	80	90	100	120	140
Indexthermometer, Minimum (*Index-Thermometer, Minimum*)		$6^{0}.8$	$4^{0}.7$	$4^{0}.2$	$4^{0}.1$	$3^{0}.9$	$3^{0}.7$	($3^{0}.8$)	($3^{0}.9$)	(3 .9)	(3 .9)	—	(4 .0)
Kviksolvpiezometer (*Mercury-Piezometer*)		6 .8	4 .8	4 .2	4 .0	3 ,9	3 .8	(3 .8)	(3 .8)	(3 .8)	(3 .9)	—	—
Vendetherm. Negr. & Zambra (*Inverting-Therm., Negr. & Zamb.*)		6 .8	4 .7	4 .1	4 .0	3 .9	3 .8	3 .9	4 .0	—	4 .3	4 .6	5 .0
Antaget Middel (*Adopted Mean*)	7 .6	6 .8	4 .7	4 .2	4 .0	3 .9	3 .8	3 .9	4 .0	—	4 .3	4 .6	5 .0

Man ser, at de to Indexthermometre give næsten constante Temperaturer under Minimum i 60 Favne, og at de ikke have kunnet angive Temperaturens Tilvæxt i de dybere Lag.

Efter saaledes at have gjort Rede for de anvendte Instrumenter, gaar jeg over til at meddele de med samme tagne Observationer.

We perceive that the two index-thermometers give well-nigh constant temperatures below the minimum at a depth of 60 fathoms, and also that they have failed to indicate the rise of temperature in the deeper strata.

Having now described the instruments, I shall pass on to the observations taken with them.

2. Dybvandstemperatur.

I Captein Willes Afhandling: "Apparaterne og deres Brug" beskrives Fremgangsmaaden ved Maalingen af Dybvandstemperaturerne saaledes:

Bundtemperatur. Lodning med Rørlod. Loddet (med Vandhenter) løftedes, saasnart Skibets Fart var standset, ud over Loddebroen, og firedes, idet en Mand drejede Svejven paa Rullen, omtrent en Favn ned. Dybvandsthermometrene sattes fra Loddebroen fast paa Lodlinen . . . . (Side 19).

Lodning med Baillie-Maskinen. Dybvandsthermometrene fastgjordes paa Lodlinen 1 à 2 Favne over Vandhenteren eller Lodderne, hvorpaa man med Indhivningsmaskinen udfirede raskt 200 eller 300 Favne (Side 22). Den paafølgende Pause benyttede jeg undertiden til at paasætte et Dybvandsthermometer, der kunde registrere Temperaturen 200 eller 300 Favne over Bunden. Stationerne 206, 217, 243, 304, 307, 308, 331, 350, 352.

Lodlinens Ophaling. Naar Loddet var kommet i Bund, gaves de medsendte Dybthermometre Tid til at antage det omgivende Vands Temperatur . . . Naar Loddet nærmede sig Vandskorpen, skede Indhivningen langsommere. Thermometrene toges af Linen, under fornøden Stands i Indhivningen, eftersom de kom over Rækken paa Loddebroen (Side 24).

2. Deep-sea Temperatures.

In Capt. Wille's Memoir, "The Apparatus and How Used," the method adopted for taking deep-sea temperatures was as follows:

Bottom-temperature. Sounding with the Tube-lead. As soon as the vessel had lost her headway, the lead (with the water-bottle attached) was lifted over the sounding-bridge, and then lowered about a fathom, a man turning the handle of the reel. The deep-sea thermometers were fastened to the line from the bridge . . . . (p. 19).

Sounding with the Baillie Machine. — The deep-sea thermometers were made fast to the line 1 or 2 fathoms above the water-bottle or the weight, after which we rapidly veered 200 or 300 fathoms of line with the donkey-engine (p. 22). The ensuing pause I sometimes took advantage of to fasten on a deep-sea thermometer, with the object of registering the temperature 200 or 300 fathoms above the bottom. Stations 206, 217, 243, 304, 307, 308, 331, 350, 352.

Heaving in the Line. — The lead having reached the bottom, sufficient time was allowed for the deep-sea thermometers to assume the temperature of the surrounding water . . . . . . On the lead nearing the surface of the water, the speed of the donkey-engine was reduced. The needful stoppages, too, were made to detach the thermometers as they came over the rail of the sounding-bridge (p. 24).

Temperaturrækker. Disse udførtes i Regelen saaledes: Rørloddet hexedes i Lodlinen, og lige ovenfor Loddet fastgjordes et Dybvandsthermometer, ganske som ved Lodning. Indhivningsmaskinen udfiredes 100 Favne, og et Thermometer No. 2 gjordes fast i Lodlinen fra Loddebroen. Atter udfiredes det andet 100 Favne og Thermometer No. 3 paasattes Linen. Paa denne Maade anbragtes 5 à 6 Thermometre paa Linen med 100 Favnes Afstand og sænkedes ved Udfiring fra Indhivningsmaskinen til de Dybder, i hvilke man vilde maale Temperaturen. Naar alle Thermometre havde faaet Tid til at accomodere sig, haledes Linen ind med Maskinen. Der stoppedes saa lang Tid, som var nødvendig for at løse Thermometrene fra Linen, efterhvert som de kom op. Der lagdes megen Vind paa jevne Bevægelser under disse Operationer, for ikke at udsætte Indexthermometrene for pludselige Ryk eller Stød. I høj Søgang maatte der benyttes megen Forsigtighed ved Thermometrenes Aftagning af Linen. Fartøjet laa i Regelen, som ved Lodning, med Stevnen mod Søen; men man kunde ikke altid holde Lodlinen saaledes, at den kunde naaes med Haanden fra Loddebroen. Linen maatte da bringes ind til Broen ved Hjelp af en Baadshage, der maatte gribe Linen *under* Thermometret for ikke at komme til at berøre dette.

Temperaturrækkerne udførtes kun meget faa Gange ved at lade Linen løbe ud fra Rullen, da dens Standsning let medførte Ryk, som ialfald Indexthermometrene ikke maa udsættes for.

Temperaturrækker paa Dybder mindre end 50 Favne udførtes ofte med Haandlod og Haandline, der havde Merker for hver 5 eller 10 Favne.

Temperaturrækkerne toges i Almindelighed strax efter et Lodskud. Flere Gange blev der dog efter Lodskuddet arbejdet med Skrabe eller Trawl, naar saadant faldt belejligere, og Temperaturrækken toges da, efterat disse Arbejder vare færdige. Paa denne Maade er det gaaet til, at Temperaturrækkens paaværende Plads (og Overfladetemperaturen) undertiden er lidt forskjellig fra Lodskuddets.

I de dybere Lag, under 600 Favne, toges sjelden Temperaturrækker, da Vandets Temperatur her kun varierede fra 0^0 til $-1^0.7$. (Side 34 og 35).

I 1876 var Lodlinen inddelt i *norske* Favne. Deraf kommer det, at Temperaturrækkerne for dette Aar, da Temperaturen maaltes i hele Tiere og Hundreder af norske Favne, udvise tilsvarende større Tal for Dybderne. Den norske Favn er nemlig 3 Procent større end den engelske, hvilket Maal overalt er benyttet i denne Afhandling.

I den følgende Tabel finder man i den

1ste Rubrik (*No*) Lodskuddets Løbenummer: de samme som i Capt. Willes Afhandling Side 30—33.

2den Rubrik (*D*). Lodskuddets Datum og Klokkeslet.

3die Rubrik (φ λ m) først Lodskuddets nordlige Bredde, derunder dets Længde fra Greenwich (E eller W), og derunder Dybderne i Meter, svarende til Favne-Tallene i 4de Rubrik.

Serial Temperatures. — The mode of operation was generally as follows: After shackling the tube-lead to the sounding-line, we attached, just above the weight, a deep-sea thermometer, precisely as for ordinary soundings. Then, 100 fathoms of line were veered out with the donkey-engine, and Thermometer No. 2 made fast from the sounding-bridge to the line, after which we veered the next 100 fathoms, and attached Thermometer No. 3 to the line. In this manner as many as 5 or 6 thermometers were made fast to the sounding-line at intervals of 100 fathoms and sent down to register the temperature in the desired depths. So soon as all the thermometers had had time to take the temperature of the surrounding water, we hauled in with the donkey-engine, stopping as each of the thermometers came up to detach it from the line. Very great importance was attached to uniformity of motion pending these operations, so as not to expose the index-thermometers to any sudden jerk or shock. In a heavy sea, we had to be specially careful in taking the thermometers off the line. The ship generally lay head to sea, as she did during the descent of the lead; nevertheless, we sometimes found it impossible to keep the line within reach from the sounding-bridge, in which case it was got in with a boat-hook, care being taken to hook the line *below* the thermometer, and thus avoid coming in contact with the latter.

Only a few serial temperatures were taken by letting the line run out of itself, the necessary stoppages in that case easily occasioning jerks, to which the index-thermometers, at least, must not be exposed.

At depths of less than 50 fathoms, serial temperatures were frequently taken with the hand-lead, the line being graduated into fives or tens of fathoms.

As a rule, we took our serial temperatures immediately after sounding. On several occasions, however, the dredge or trawl was worked in preference, the serial temperatures being in that case deferred till we had terminated those operations. This accounts for the position in which certain of the serial temperatures (and the surface-temperature) were taken differing slightly from that of the soundings.

At depths exceeding 600 fathoms we seldom took serial temperatures, the temperature in the deeper strata varying only from 0^0 to $-1^0.7$ (p. 34 and 35).

In 1876, the sounding-line was divided into *Norwegian* fathoms. This accounts for the serial temperatures taken that year, since the temperature was measured at whole tens and hundreds of Norwegian fathoms, showing relatively higher figures for the depths. The Norwegian fathom is namely 3 per cent longer than the English — the measure to be everywhere understood throughout this Memoir.

In the following Table will be found: —

Column 1 (*No*). Number of Sounding; the same as in Capt. Wille's Memoir, p. 30—33.

Column 2 (*D*). Date of Sounding and Hour.

Column 3 (φ λ m). First: North Latitude of Sounding; underneath its Longitude from Greenwich (E or W); and then the Depths in Metres, corresponding to the Fathom-Numbers in Column 4.

4de Rubrik (h). Dybden i engelske Favne. Det øverste Tal er Lodskuddet, det er Havbundens Dybde under Overfladen.

5te Rubrik (Th). Det benyttede Dybvandsthermometers Betegnelse.

6te Rubrik (t'). Den aflæste Temperatur eller Skaladel paa Dybvandsthermometret.

7de Rubrik (c_s). Thermometrets Skala-Correction.

8de Rubrik (t_s). Den for Skala-Fejlen corrigerede Temperatur.

9de Rubrik (c_p). Thermometrets Tryk-Correction.

10de Rubrik (t_r). Den for Skala-Fejl og Tryk reducerede Temperatur.

11te Rubrik (t). Den antagne Temperatur i Celsiusgrader. I Regelen er denne opført i Tiendedelsgrader, men hvor den er bestemt med større Nøjagtighed, ved Hjelp af flere vel sammenstemmende Thermometre, i Hundrededelsgrader.

Column 4 (h). Depth in English Fathoms. The top figure is for the sounding, and indicates the depth of the sea-bed beneath the surface of the sea.

Column 5 (Th). Designation of deep-sea Thermometer used.

Column 6 (t'). Temperature of, or scale-division on, deep-sea Thermometer.

Column 7 (c_s). Scale-Correction of Thermometer.

Column 8 (t_s). Temperature corrected for Error of Scale.

Column 9 (c_p). Pressure-Correction of Thermometer.

Column 10 (t_r). Temperature reduced for Error of Scale and Pressure.

Column 11 (t). The adopted Temperature in degrees Centigrade. As a rule, this has been given to tenths of a degree; but when determined with greater accuracy, by means of several thermometers showing good agreement, to hundredths of a degree.

Dybvandstemperaturer.

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1876	° ′								
1.	Juni 3	61 13 N.	500							
			+ x		°				°	°
	1.0 p.m.	6 36 E.	0		12.1	°	°		12.1	12.1
		914 + x	500	V	6 5	+0.09	6.59		6.59	6.6
			+ x							
2.	Juni 3									
	2.0 p.m.	61 10	672							
		6 32 E.	0		11.6				11.6	11.6
		1229	672	V	6.6	+0.09	6.69		6.69	6.7
3.	Juni 8									
	4.55 p.m.	61 55	618							
		5 15 E.	0		9.7				9.7	9.7
		1130	618	V	6.5	+0.09	6.59		6.59	6.6
4.	Juni 8									
	5.45 p.m.	61 5	566							
		5 14 E.	0		8.6				8.6	8.6
		1035	566	V	6.53	+0.09	6.62		6.62	6.6
5.	Juni 8									
	6.30 p.m.	61 6	504							
		5 12 E.	0		8.5				8.5	8.5
		922	504	V	6.55	+0.09	6.64		6.64	6.6
6.	Juni 9									
	8.0 a.m.	61 6	211							
		5 9 E.	0		8.5				8.5	8.5
		386	211	V	6.55	+0.09	6.64	-0.02	6.62	6.6
7.	Juni 9									
	8.30 a.m.	61 6	206							
		5 11 E.	0		8.7				8.7	8.7
		377	206	V	6.55	+0.09	6.64	-0.02	6.62	6.6
8.	Juni 9									
	10.0 a.m.	61 0	200							6.6
		4 49 E.								
9.	Juni 20									
	4.15 p.m.	61 30	206							
		3 37 E.	0		10.0				10.0	10.0
		377	206	V	5.7	+0.10	5.87	-0.02	5.85	5.9
10.	Juni 21									
	9.0 a.m.	61 41	220							
		3 19 E.	0		11.5				11.5	11.5
		402	220	V	5.9	+0.10	6.00	-0.02	5.98	6.0

No. 8. Bundtemp. efter No. 7.
Bottom-Temp. from No. 7.

Deep-Sea Temperatures.

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1876									
11.	Juni 21	° ′								
	10.0 a.m.	61 47	232		°				°	°
		3 9 E.	0		11.1	°	°		11.1	11.1
		424	232	V	6.0	+0.10	6.10	-0.02	6.08	6.1
12.	Juni 21	61 53	223							
	11.15 a.m.	3 0 E.	0		11.1				11.1	11.1
		408	223	V	6.2	+0.09	6.29	-0.02	6.27	6.3
13.	Juni 21	61 58	228							
	0.0 p.m.	2 54 E.	0		10.2				10.2	10.2
		417	228	V	6.0	+0.10	6.10	-0.03	6.07	6.1
14.	Juni 21	62 4	226							
	1.35 p.m.	2 45 E.	0		9.9				9.9	9.9
		413	226	V	6.0	+0.10	6.10	-0.03	6.07	6.1
15.	Juni 21	62 10	221							
	3.0 p.m.	2 36 E.	0		11.3				11.3	11.3
		404	221	V	6.0	+0.10	6.10	-0.02	6.08	6.1
16.	Juni 21	62 24	221							
	5.15 p.m.	2 17 E.	0		10.9				10.9	10.9
		404	221	V	4.55	+0.11	4.66	-0.02	4.64	4.6
17.	Juni 21	62 33	288							
	7.5 p.m.	2 4 E.	0		11.2				11.2	11.2
		527	288	V	2.3	+0.14	2.44	-0.04	2.40	2.4
18.	Juni 21	62 44	412							
	9.30 p.m.	1 48 E.	0		11.6				11.6	11.6
		18	10	VII	10.0	+0.22	10.22		10.22	10.2
		38	21	VII	8.8	+0.23	9.03		9.03	9.0
		57	31	VII	8.4	+0.23	8.63		8.63	8.6
		75	41	VII	8.2	+0.23	8.43		8.43	8.4
		93	51	VII	8.0	+0.23	8.23	-0.01	8.22	8.2
		188	103	II	6.5	+0.19	6.69	-0.02	6.67	6.7
		377	206	V	4.05	+0.12	4.17	-0.02	4.15	4.2
		565	309	II	-0.45	+0.07	-0.38	-0.03	-0.35	-0.4
		753	412	V	-1.1	+0.19	-0.91	-0.05	-0.96	-1.0
19.	Juni 22	62 23	226							
	1.20 p.m.	2 50 E.	0		11.0				11.0	11.0
		229	125	VII	6.7	+0.25	6.95	-0.01	6.94	6.9
		413	226	V	5.9	+0.10	6.00	-0.02	5.98	6.0
20.	Juni 22	62 16	219							
	3.15 p.m.	3 8 E.	0		11.2				11.2	11.2
		400	219	V	6.1	+0.10	6.20	-0.02	6.18	6.2
21.	Juni 22	62 14	188							
	4.30 p.m.	3 28 E.	0		13.4				13.4	13.4
		344	188	V	5.7	+0.10	5.80	-0.02	5.78	5.8

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1876	° ′								
22.	Juni 22	62 13	129		°				°	°
	5.45 p.m.	3 41 E.	0		12.6	°	°	°	12.6	12.6
		236	129	V	5.9	+0.10	6.00	-0.01	5.99	6.0
23.	Juni 23	62 52	80							
	4^h-8^h a.m.	5 50 E.								
24.	Juni 27	63 10	90							
	10^h 30 p.m.	5 58 E.	0		11.7				11.7	11.7
		18	10	II	7.0	+0.20	7.20		7.20	7.2
		38	21	II	6.5	+0.19	6.69		6.69	6.7
		57	31	II	6.7	+0.19	6.89		6.89	6.9
		75	41	II	6.5	+0.19	6.69	-0.01	6.68	6.7
		93	51	II	6.5	+0.19	6.69	-0.01	6.68	6.7
		165	90	VII	6.7	+0.25	6.95	-0.01	6.94	6.9
25.	Juni 28	63 10	98							
	4^h-11^h a.m.	5 25 E.								6.9
26a.	Juni 28	63 10	237							
	0.50 p.m.	5 16 E.	0		11.8				11.8	11.8
		433	237	VII	6.9	+0.25	7.15	-0.03	7.12	7 1
26b.	Juni 28									
	5.0 p.m.	63 7	90							
		5 17 E.	0		11.7				11.7	11.7
		20	11	V	9.9	+0.05	9.95		9.95	10.0
		38	21	V	9.05	+0.06	9.11		9.11	9.1
		57	31	V	8.95	+0.06	9.01		9.01	9.0
		84	46	V	8.8	+0.06	8.86	-0.01	8.85	8.9
		165	90	II	7.5	+0.20	7.70	-0.02	7.68	7.7
		"	"	VII	7.6	+0.24	7.84	-0.01	7.83	7.8
27.	Juni 28	63 6	87							
	5.30 p.m.	5 18 E.								7.8
28.	Juni 29	63 10	396							
	4.45 a.m.	5 11 E.	0		11.4				11.4	11.4
		724	396	V	-0.6	+0.18	-0.42	-0.05	-0.47	-0.5
29.	Juni 29	63 10	396							
	5.30 a.m.	5 7 E.	0		11.4				11.4	11.4
		724	396	V	-0.3	+0.17	-0.13	-0.05	-0.18	-0.2
		"	"	VII	-0.4	+0.31	-0.09	-0.04	-0.13	
30.	Juni 29	63 10	401							
	6.15 a.m.	5 4 E.	0		11.7				11.7	11.7
		733	401	V	-0.6	+0.18	-0.42	-0.05	-0.47	-0.4
		"	"	VII	-0.6	+0.31	-0.29	-0.04	-0.33	
31.	Juni 29	63 10	417							
	7.10 a.m.	5 0 E.	0		11.5				11.5	11.5
		763	417	V	-1.2	+0.19	-1.01	-0.05	-1.06	-1.0
		"	"	VII	-1.1	+0.32	-0.78	-0.04	-0.82	
32.	Juni 29	63 10	430							
	5.15 p.m.	4 51 E.	0		11.6				11.6	11.6
		20	11	NZ	11.8				11.8	11.7
		"	"	V	11.6	+0.03	11.63		11.63	
		29	16	NZ	9.0				9.0	9.0
		38	21	NZ	10.0				10.0	9.7
		"	"	V	9.5	+0.05	9.55		9.55	
		57	31	NZ	9.1				9.1	9.1
		"	"	V	9.1	+0.06	9.16		9.16	
		84	46	NZ	9.0				9.0	9.0
		"	"	NZ	8.9				8.9	
		"	"	V	9.0	+0.06	9.06		9.06	
		188	103	VII	8.2	+0.24	8.44	-0.01	8.43	8.4
		377	206	VII	6.6	+0.25	6.85	-0.02	6.83	6.8
		565	309	V	5.6	+0.10	5.70	-0.04	5.66	5.7
		786	430	VII	-0.9	+0.31	-0.59	-0.05	-0.64	-0.6
33.	Juni 30	63 5	525							
	4.0 a.m.	3 0 E.	0		11.8				11.8	11.8
		960	525	V	-1.2	+0.19	-1.01	-0.06	-1.07	-1.1
34.	Juli 1	63 5	587							
	3.0 a.m.	0 53 E.	0		11.8				11.8	11.8
		1073	587	VII	-1.2	+0.32	-0.88	-0.07	-0.95	-1.0
35.	Juli 4	63 7	1081							
	6.30 a.m.	1 26 W.	0		10.4				10.4	10.4
		1977	1081	V	-1.05	+0.18	-0.87	-0.12	-0.99	-1.0
	1876	° ′								
35b.	Juli 5	63 21			°				°	°
	6.0 p.m.	1 16 W.	0		10.8	°	°	°	10.8	10.8
		1130	618	VII	-0.8	+0.32	-0.48	-0.07	-0.55	-0.6
		1319	721	V	-1.0	+0.19	-0.81	-0.09	-0.90	-0.9
extra	Juli 11	Thors-								
	12.30 p.m.	havns Red	0	VII	9.1	+0.3	9.4		9.4	9.4
		2	1	VII	9.0	+0.3	9.3		9.3	9.3
		4	2	VII	8.95	+0.3	9.25		9.25	9.3
		9	5	VII	9.0	+0.3	9.3		9.3	9.3
		18	10	VII	8.95	+0.3	9.25		9.25	9.3
36.	Juli 17	62 15	148							
	1.45 a.m.	4 34 W.	0		9.4				9.4	9.4
		271	148	V	7.8	+0.08	7.88	-0.02	7.86	7.9
37.	Juli 17	62 28	690							
	9.30 a.m.	2 29 W.	0		10.4				10.4	10.4
		20	11	VII	10.0	+0.52	10.52		10.52	10.5
		57	31	II	8.4	+0.22	8.62		8.62	8.6
		93	51	V	7.9	+0.07	7.97	-0.01	7.96	8.0
		188	103	VII	6.75	+0.57	7.32	-0.01	7.31	7.3
		377	206	II	3.4	+0.14	3.54	-0.03	3.51	3.5
		565	309	V	0.0	+0.17	0.17	-0.04	0.13	0.1
		1262	690	V	-1.15	+0.09	-1.06	-0.08	-1.14	-1.1
38.	Juli 17	63 1	204							
	9.0 p.m.	3 58 W.	0		10.3				10.3	10.3
		373	204	V	0.6	+0.16	0.76	-0.02	0.74	0.7
39.										
40.	Juli 18	63 22	1215							
	8.30 a.m.	5 29 W.	0		9.7				9.7	10.0
		0	0		10.3				10.3	
		20	11	IV	9.55	+0.29	9.84		9.84	9.8
		38	21	II	8.8	+0.23	9.03		9.03	9.0
		57	31	VII	8.0	+0.56	8.56		8.56	8.6
		75	41	III	7.85	+0.23	8.08		8.08	8.1
		93	51	V	7.85	+0.07	7.92	-0.01	7.91	7.9
		188	103	VII	7.4	+0.57	7.97	-0.01	7.96	8.0
		377	206	II	1.5	+0.10	1.60	-0.04	1.56	1.6
		565	309	V	0.4	+0.17	0.57	-0.04	0.53	0.5
		753	412	IV	-0.2	+0.04	-0.16	-0.03	-0.19	-0.2
		942	515	III	-0.5	+0.15	-0.35	-0.05	-0.40	-0.4
		1882	1029	V	-1.1	+0.19	-0.91	-0.12	-1.03	-1.0
		2222	1215	V	-1.25	+0.19	-1.06	-0.14	-1.20	-1.2
41.	Juli 19	63 37	697							
	1.15 p.m.	7 10 W.	0		9.2				9.2	9.2
		1275	697	V	-1.1	+0.19	-0.91	-0.08	-0.99	-1.0
42.	Juli 20	63 2	264							
	10.30 p.m.	10 17 W.	0		9.9				9.9	9.9
		93	51	VII	8.0	+0.56	8.56	-0.00	8.56	8.6
		104	57	VII	8.0	+0.56	8.56		8.56	8.6
		294	161	II	6.0	+0.18	6.18	-0.03	6.15	6.2
		483	264	V	1.2	+0.16	1.36	-0.03	1.33	1.3
43.	Juli 21	63 11	529							
	0.15 p.m.	13 32 W.	0		10.7				10.7	10.7
		38	21	IV	10.2	+0.31	10.51		10.51	10.5
		93	51	III	8.3	+0.24	8.54	-0.01	8.53	8.5
		214	117	III	8.1	+0.24	8.34	-0.01	8.33	8.3
		402	220	IV	7.7	+0.25	7.95	-0.02	7.93	7.9
		591	323	VII	7.9	+0.56	8.46	-0.03	8.43	7.4
		779	426	II	6.6	+0.19	6.79	-0.08	6.71	6.7
		967	529	V	2.8	+0.14	2.94	-0.06	2.88	2.9
44.	Aug. 5	63 8	844							
	10.0 a.m.	14 0 W.	0		10.7				10.7	10.7
		1543	844	V	2.65	+0.14	2.79	-0.10	2.69	2.7
45.	Aug. 5	63 28	381							
	7.35 p.m.	12 58 W.	0		10.4				10.4	10.4
		38	21	VII	10.2	+0.54	10.74		10.74	10.7
		93	51	II	9 75	+0.24	9.99	-0.01	9.98	10.0
		188	103	IV	8.0	+0.25	8.25	-0.01	8.24	8.2
		377	206	III	7.75	+0.23	7.98	-0.02	7.96	8.0
		565	309	V	7.1	+0.08	7.18	-0.04	7.14	7.1
		697	381	V	4.25	+0.12	4.37	-0.04	4.33	4.3

No. 25. Bundtemp. efter No. 24.
Bottom-Temp. from No. 24

No. 40. I 103 Fv. synes No. VII at have vist for højt.
In 103 fathoms, No. VII would seem to have registered too high.

No. 43. Temp. i 323 Fv. antaget at være aflæst en Grad for højt.
Temp. in 323 fms. assumed read one degree too high.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1876	° ′								
46.	Aug. 6.	63 51	257		°				°	°
	0.30 a.m.	12 5 W.	0		9.7	°	°	°	9.7	9.7
		470	257	VII	3.3	+0.60	3.90	-0.03	3.87	3.9
47.	Aug. 6.	64 13	190							
	5.10 a.m.	11 14 W.	0		9.6				9.6	9.6
		38	21	VII	9.1	+0.55	9.65		9.65	9.6
		93	51	V	8.3	+0.06	8.36	-0.01	8.35	8.4
		188	103	IV	7.5	+0.25	7.75	-0.01	7.74	7.7
		347	190	IV	5.8	+0.20	6.00	-0.01	5.99	6.0
48.	Aug. 6	64 36	299							
	10.10 a.m.	10 22 W.	0		5.3				5.3	5.7
	4 p.m.	0	0		6.1				6.1	
		38	21	III	3.2	+0.19	3.39		3.39	3.4
		93	51	IV	1.2	+0.08	1.28		1.28	1.3
		188	103	II	0.4	+0.09	0.49	-0.02	0.47	0.5
		377	206	V	-0.5	+0.18	-0.32	-0.02	-0.34	-0.3
		547	299	VII	-0.7	+0.64	-0.06	-0.03	-0.09	-0.3
49.	Aug. 6	65 0	437							
	9.45 p.m.	9 25 W.	0		6.8				6.8	6.8
		799	437	V	-0.9	+0.18	-0.72	-0.05	-0.77	-0.8
50.	Aug. 7	65 26	571							
	3.30 a.m.	8 24 W.	0		7.8				7.8	7.8
		1044	571	V	-1.0	+0.19	-0.81	-0.07	-0.88	-0.9
51.	Aug. 7	65 53	1163							
	9.45 a.m.	7 18 W.	0		8.0				8.0	8.0
		20	11	III	7.9	+0.13	8.03		8.03	8.0
		38	21	VII	3.7	+0.60	4.30		4.30	4.3
		57	31	II	1.55	+0.11	1.66		1.66	1.7
		75	41	IV	0.6	+0.06	0.66		0.66	0.7
		93	51	VII	0.5	+0.63	1.13		1.13	0.4
		188	103	IV	0.05	+0.05	0.10	-0.01	0.09	0.1
		282	154	II	0.05	+0.08	0.13	-0.03	0.10	0.1
		377	206	VII	-0.6	+0.64	0.04	-0.02	0.02	0.07
		„	„	III	0.0	+0.13	0.13	-0.02	0.11	
		565	309	V	-0.6	+0.18	-0.42	-0.04	-0.46	-0.5
		942	515	II	-0.4	+0.07	-0.33	-0.09	-0.42	-0.55
		„	„	V	-0.8	+0.18	-0.62	-0.06	-0.68	
		1319	721	III	-1.0	+0.13	-0.87	-0.07	-0.94	-0.9
		1693	926	IV	-1.05	+0.02	-1.03	-0.07	-1.10	-1.1
		2127	1163	V	-1.2	+0.19	-1.01	-0.13	-1.14	-1.1
52.	Aug. 8	65 47	1861							
	10.45 a.m.	3 7 W.	0		9.7				9.7	10.0
		0	0		10.2				10.2	
		20	11	II	10.0	+0.25	10.25		10.25	10.2
		57	31	VII	6.75	+0.55	7.30		7.30	7.3
		93	51	III	6.05	+0.11	6.16		6.16	6.2
		188	103	III	5.5	+0.21	5.71	-0.11	5.60	5.6
		377	206	VII	3.75	+0.60	4.35	-0.02	4.33	4.3
		565	309	II	1.4	+0.10	1.50	-0.05	1.45	1.5
		753	412	IV	0.0	+0.05	0.05	-0.03	0.02	0.0
		942	515	V	-0.5	+0.18	-0.32	-0.06	-0.38	-0.4
		3403	1861	V	-1.15	+0.19	-0.96	-0.21	-1.17	-1.17
		„	„	III	-1.05	+0.07	-0.98	-0.19	-1.17	
53.	Aug. 10	65 13	1539							
	10.0 a.m.	0 33 E.	0		10.5				10.5	10.5
		188	103	VII	5.3	+0.58	5.88		5.88	5.9
		377	206	III	1.9	+0.17	2.07	-0.02	2.05	2.1
		565	309	II	0.3	+0.08	0.38	-0.05	0.33	0.3
		753	412	V	-0.3	+0.18	-0.12	-0.05	-0.17	-0.2
		942	515	IV	-0.65	+0.03	-0.62	-0.04	-0.66	-0.7
		2913	1539	V	-1.25	+0.19	-1.06	-0.18	-1.24	-1.26
		„	„	IV	-1.2	+0.02	-1.18	-0.11	-1.29	

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1876	° ′								
54.	Aug. 12	64 47	601		°				°	°
	9.0 a.m.	4 24 E.	0		11.0	°	°		11.0	11.0
		20	11	VII	10.8	+0.2	11.0		11.0	11.0
		38	21	III	10.7	+0.25	10.95		11.0	11.0
		57	31	V	8.4	+0.07	8.47		8.47	8.5
		75	41	II	7.7	+0.21	7.91		7.91	7.9
		93	51	IV	7.35	+0.24	7.59	0	7.59	7.6
		188	103	VII	6.9	+0.27	7.17	-0.01	7.16	7.2
		377	206	IV	5.4	+0.19	5.59	-0.01	5.58	5.6
		565	309	II	1.25	+0.10	1.35	-0.03	1.32	1.3
		753	412	V	-0.8	+0.18	-0.62	-0.05	-0.67	-0.7
		942	515	III	-1.1	+0.15	-0.95	-0.05	-1.00	-1.0
		1099	601	V	-1.35	+0.19	-1.16	-0.07	-1.23	-1.22
		„	„	III	-1.2	+0.06	-1.14	-0.06	-1.20	
55.	Aug. 20	64 38	93							
	7.15 p.m.	10 22 E.	0		13.0				13.0	13.0
		170	93	V	7.1	+0.08	7.18	-0.01	7.17	7.2
56.	Aug. 20	64 39	178							
	8.0 p.m.	10 11 E.	0		12.8				12.8	12.8
		326	178	V	7.1	+0.08	7.18	-0.02	7.16	7.2
57.	Aug. 20	64 39	161							
	9.0 p.m.	9 59 E.	0		12.6				12.6	12.6
		294	161	V	6.95	+0.08	7.03	-0.02	7.01	7.0
58.	Aug. 20	64 39	221							
	9.45 p.m.	9 49 E.	0		11.7				11.7	11.7
		404	221	V	6.75	+0.09	6.84	-0.02	6.86	6.9
59.	Aug. 20	64 39	167							
	10.45 p.m.	9 38 E.	0		11.7				11.7	11.7
		305	167	V	6.8	+0.09	6.89	-0.02	6.91	6.9
60.	Aug. 20	64 40	118							
	11.25 p.m.	9 30 E.	0		11.8				11.8	11.8
		216	118	V	6.95	+0.09	7.04	-0.01	7.03	7.0
61.	Aug. 21	64 40	118							
	0.10 a.m.	9 19 E.	0		11.8				11.8	11.8
		216	118	V	6.95	+0.09	7.04	-0.01	7.03	7.0
62.	Aug. 21	64 41	108							
	1.0 a.m.	9 10 E.	0		11.6				11.6	11.6
		198	108	V	6.9	+0.09	6.99	-0.01	6.98	7.0
63.	Aug. 21	64 41	93							
	1.50 a.m.	9 0 E.	0		11.6				11.6	11.6
		170	93	V	6.9	+0.09	6.99	-0.01	6.98	7.0
64.	Aug. 21	64 42	58							
	2.45 a.m.	8 50 E.	0		11.5				11.5	11.5
		106	58	V	7.6	+0.08	7.68	-0.01	7.67	7.7
65.	Aug. 21	64 42	62							
	3.30 a.m.	8 39 E.	0		11.5				11.5	11.5
		113	62	V	7.3	+0.08	7.38	-0.01	7.37	7.4
66.	Aug. 21	64 43	88							
	4.15 a.m.	8 30 E.	0		11.5				11.5	11.5
		161	88	V	7.0	+0.08	7.08	-0.01	7.07	7.1
67.	Aug. 21	64 44	119							
	5.15 a.m.	8 19 E.	0		11.5				11.5	11.5
		218	119	II	6.7	+0.19	6.89	-0.02	6.87	6.9
68.	Aug. 21	64 44	132							
	6.0 a.m.	8 9 E.	0		11.6				11.6	11.6
		241	132	II	6.7	+0.19	6.89	-0.02	6.87	6.9
69.	Aug. 21	64 45	128							
	7.0 a.m.	8 2 E.	0		11.5				11.5	11.5
		234	128	II	6.8	+0.19	6.99	-0.02	6.97	7.0
70.	Aug. 21	64 45	130							
	7.45 a.m.	7 53 E.	0		11.6				11.6	11.6
		238	130	II	6.8	+0.19	6.99	-0.02	6.97	7.0
71.	Aug. 21	64 45	132							
	8.30 a.m.	7 46 E.	0		11.6				11.6	11.6
		241	132	II	6.8	+0.19	6.99	-0.02	6.97	7.0

No. 48. Therm. No. VII synes upaalideligt. Bundtemp. antaget til -0°.3.
Therm. No. VII apparently unreliable. Temp. assumed -0°.3.

No. 51. Therm. No. VII synes upaalideligt. Temp. i 51 Favne efter Curven +0°.4.
Therm. No. VII would seem unreliable. — Temp. in 51 fms. from curve +0°.4.

No. 54 Therm. No. VII synes i 11 Favne at kræve en Correction af +0°.2 istedetfor +0°.5. Herefter er Obs. i 11 Fv. og i 103 Fv. rettede.
Therm. No. VII would seem to have in 11 fms. a correction of +0°.2 instead af +0°.5. Accordingly, the obs. in 11 faths. and that in 103 fms. have been corrected.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1876	° ′			°	°	°	°	°	°
72.	Aug. 21	64 46	137							
	9.15 a.m.	7 37 E.	0		11.7				11.7	11.7
		251	137	II	6.7	+0.19	6.89	-0.02	6.87	6.9
73.	Aug. 21	64 46	133							
	10.0 a.m.	7 28 E.	0		11.3				11.3	11.3
		243	133	II	6.8	+0.19	6.99	-0.02	6.97	7.0
74.	Aug. 21	64 47	132							
	10.45 a.m.	7 20 E.	0		11.3				11.3	11.3
		241	132	II	6.7	+0.19	6.89	-0.02	6.87	6.9
75.	Aug. 21	64 47	145							
	11.45 a.m.	7 13 E.	0		11.2				11.2	11.2
		265	145	II	6.7	+0.19	6.89	-0.02	6.87	6.9
76.	Aug. 21	64 47	149							
	0.24 p.m.	7 4 E.	0		11.2				11.2	11.2
		272	149	II	6.8	+0.19	6.99	-0.03	6.96	7.0
77.	Aug. 21	64 48	149							
	1.10 p.m.	6 54 E.	0		11.2				11.2	11.2
		272	149	II	6.7	+0.19	6.89	-0.03	6.86	6.9
78.	Aug. 21	64 48	155							
	2.15 p.m.	6 45 E.	0		11.5				11.5	11.5
		283	155	II	6.8	+0 19	6.99	-0.03	6.96	7.0
79.	Aug. 21	64 48	155							
	3.30 p.m.	6 36 E.	0		11.4				11.4	11.4
		283	155	II	6.7	+0.19	6.89	-0.03	6.86	6.9
80	Aug. 21	64 48	144							
	6.0 p.m.	6 26 E.	0		11.6				11.6	11.6
		263	144	II	6.6	+0.19	6.79	-0.03	6.76	6.8
81.	Aug. 21	64 49	155							
	6.45 p.m.	6 17 E.	0		11.6				11.6	11.6
		283	155	II	6.7	+0.19	6.89	-0.03	6.86	6.9
82.	Aug. 21	64 49	175							
	7.30 p.m.	6 7 E.	0		11.5				11.5	11.5
		320	175	II	6.7	+0.19	6.89	-0.03	6.86	6.9
83.	Aug. 21	64 49	185							
	8.20 p.m.	5 58 E.	0		11.4				11.4	11.4
		338	185	II	6.8	+0.19	6.99	-0.03	6.96	7.0
84.	Aug. 21	64 49	221							
	9.15 p.m.	5 49 E.	0		11.2				11.2	11.2
		404	221	II	6.3	+0.19	6.49	-0.04	6.45	6.5
85.	Aug. 21	64 50	303							
	10.0 p.m.	5 39 E.	0		11.3				11.3	11.3
		554	303	II	3.8	+0.14	3.94	-0.05	3.89	3.9
86.	Aug. 21	64 50	381							
	11.15 p.m.	5 30 E.	0		11.3				11.3	11.3
		697	381	II	-1.0	+0.07	-0.93	-0.07	-1.00	-1.0
87.	Aug. 22	64 2	498							
	6.30 a.m.	5 35 E.	0		11.7				11.7	12.0
	11.30 a.m.	„	0		12.2				12.2	
		20	11	VI	10.7	+0.39	11.09		11.09	11.1
		38	21	VII	10.6	+0.54	11.10		11.10	11.1
		57	31	IV	10.4	+0.32	10.72		10.72	10.7
		66	36	II	9.6	+0.24	9.84	-0.01	9.83	9.8
		93	51	III	9.0	+0.27	9.27	-0.01	9.26	9.3
		188	103	VI	7.4	+0.31	7.71	-0.01	7.70	7.7
		377	206	III	6.6	+0.22	6.82	-0.02	6.80	6.8
		565	309	VII	2.6	+0.61	3.21	-0.02	3.19	3.2
		649	355	IV	-0.05	+0.05	0.00	-0.03	-0 03	-0.0
		753	412	II	-0.95	+0.06	-0.89	-0.08	-0.81	-0.8
		911	498	II	-1.2	+0.06	-1.14	-0.09	-1.05	-1.1
88.	Aug. 22	64 1	355							
	1.30 p.m.	5 53 E.	0		12.2				12.2	12.2
		649	355	III	2.65	+0.12	2.77	-0.04	2.73	2.7
89.	Aug. 22	64 1	190							
	3.0 p.m.	6 8 E.	0		12.2				12.2	12.2
		347	190	II	6.5	+0.19	6.69	-0.03	6.66	6.7
90.	Aug. 22	64 1	205							
	4.0 p.m.	6 21 E.	0		12.0				12.0	12.0
		375	205	II	6.45	+0.19	6.64	-0.03	6.61	6.6
91.	Aug. 22	64 0	190							
	4.45 p.m.	6 32 E.	0		12.0				12.0	12.0
		347	190	II	7.0	+0.20	7.20	-0.03	7.17	7.2

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1876	° ′			°	°	°	°	°	°
92.	Aug. 22	64 0	178							
	7.30 p.m.	6 42 E.	0		11.2				11.2	11.2
		93	51	VII	10.4	+0.54	10.94		10.94	10.9
		188	103	III	8.3	+0.26	8.56	-0.01	8.55	8.6
		283	155	II	7.3	+0.20	7.50	-0.03	7.47	7.5
		326	178	II	7.0	+0.20	7.20	-0.03	7.17	7.2
93.	Aug. 24	62 41	158							
	9.45 a.m.	7 8 E.	0		14.1				14.1	14.1
		20	11	VII	11.6	+0.53	12.13		12.13	12.1
		38	21	III	10.6	+0.30	10.90		10.90	10.9
		57	31	IV	9.2	+0.28	9.48	-0.00	9.48	9.5
		75	41	II	7.2	+0.20	7.40	-0.01	7.39	7.4
		93	51	IV	6.8	+0.22	7.02	-0.00	7.02	7.0
		132	72	III	6.3	+0.22	6.52	-0.01	6.51	6.5
		188	103	VII	6.4	+0.58	6.98	-0.01	6.97	6.5
		„	„	VI	6.25	+0.28	6.53	-0.01	6.52	
		283	155	VI	6.0	+0.27	6.27		6.27	6.3
		289	158	VI	6.1	+0.27	6.37		6.37	6.41
		„	„	III	6.25	+0.21	6.46		6.46	
	1877									
94.	Juni 13	59 8	145							
	4.30 p.m.	4 38 E.	0		9.8				9.8	9.8
		18	10	III	7.0	+0.17	7.17		7.17	7.2
		27	15	III	6.4	+0.16	6.56		6.56	6.6
		37	20	VII	4.7	+0.10	4.80		4.80	4.8
		55	30	VI	4.6	+0.24	4.84		4.84	4.8
		73	40	IV	4.7	+0.17	4.87		4.87	4.9
		91	50	III	4.8	+0.14	4.94	-0.01	4.93	4.9
		„	„	IV	4.7	+0.17	4.87	-0.01	4.86	
		183	100	III	4.9	+0.14	5.04	-0.01	5.03	5.0
		256	140	III	4.85	+0.14	4.99	-0.01	4.98	4.97
		„	„	IV	4.8	+0.17	4.97	-0.01	4.96	
95.	Juni 14	60 42	175							
	8.0 a.m.	4 14 E.	0		9.4				9.4	9.4
		37	20	VI	8.3	+0.33	8.63		8.63	8.6
		91	50	III	5.5	+0.15	5.65	-0.01	5.64	5.6
		183	100	IV	5.7	+0.20	5.90	-0.01	5.89	5.9
		320	175	III	5.7	+0.05	5.75	-0.01	5.74	5.76
		„	„	IV	5.6	+0.19	5.79	-0.01	5.78	
96.	Juni 16	66 8	805							
	6.0 a.m.	3 0 E.	0		8.2				8.2	8.2
		91	50	I	6.5	+0.06	6.56	-0.01	6.55	6.6
		183	100	I	5.9	+0.06	5.96	-0.02	5.94	5.9
		366	200	VII	5.6	+0.09	5.69	-0.02	5.67	5.7
		549	300	VI	4.6	+0.24	4.84	-0.03	4.81	4.8
		732	400	IV	1.5	+0.09	1.59	-0.03	1.56	1.6
		914	500	III	-0.15	+0.06	-0.09	-0.05	-0.14	-0.1
		1472	805	III	-1.1	+0.04	-1.06	-0.08	-1.14	-1.12
		„	„	IV	-1.05	+0.02	-1.03	-0.06	-1.09	
		„	„	B	232.0		-2.26	+1.23	-1.13	
97.	Juni 16	66 2	683							
	6.30 p.m.	4 21 E.	0		8.1				8.1	8.1
		1249	683	III	-1.1	+0.04	-1.06	-0.07	-1.13	-1.13
		„	„	IV	-1.1	+0.02	-1.08	-0.05	-1.13	
		„	„	B	231.5		-2.10	+0.96	-1.14	
98.	Juni 16	65 56	388							
	10.30 p.m.	5 21 E.	0		9.0				9.0	9.0
		710	388	III	-1.0	+0.05	-0.95	-0.04	-0.99	-0.99
		„	„	IV	-1.0	+0.02	-0.98	-0.03	-1.01	
		„	„	B	229.8		-1.52	+0.55	-0.97	
99.	Juni 17	65 51	213							
	2.45 a.m.	6 25 E.	0		8.9				8.9	8.9
		390	213	III	6.0	+0.16	6.16	-0.02	6.14	6.11
		„	„	IV	5.9	+0.20	6.10	-0.01	6.09	
100.	Juni 17	65 43	194							
	6.25 a.m.	7 29 E.	0		8.9				8.9	8.9
		355	194	III	5.9	+0.16	6.06	-0.02	6.04	6.01
		„	„	IV	5.8	+0.20	6.00	-0.01	5.99	
101.	Juni 17	65 36	223							
	10.0 a.m.	8 32 E.	0		9.4				9.4	9.4
		408	223	III	5.9	+0.16	6.06	-0.02	6.04	6.01
		„	„	IV	5.8	+0.20	6.00	-0.02	5.98	

No. 93. Romsdalsfjord.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′								
102.	Juni 17	65 32	211		°				°	°
	3.30 p.m.	9 10 E.	0		9.0	°	°	°	9.0	9.0
		386	211	III	6.05	+0.16	6.21	-0.02	6.19	6.01
		„	„	IV	5.95	+0.20	6.15	-0.02	6.13	
103.	Juni 17	65 30	193							
	5.0 p.m.	9 37 E.	0		9.3				9.3	9.3
		353	193	III	6.2	+0.16	6.36	-0.02	6.34	6.37
		„	„	IV	6.2	+0.21	6.41	-0.01	6.40	
104.	Juni 17	65 28	162							
	6.15 p.m.	9 56 E.	0		9.1				9.1	9.1
		296	162	III	6.35	+0.16	6.51	-0.02	6.49	6.50
		„	„	IV	6.3	+0.21	6.51	-0.01	6.50	
105.	Juni 17	65 26	145							
	7.30 p.m.	10 13 E.	0		8.7				8.7	8.7
		265	145	III	6.4	+0.16	6.56	-0.01	6.55	6.58
		„	„	IV	6.4	+0.21	6.61	-0.01	6.60	
106.	Juni 17	65 24	177							
	8.45 p.m.	10 33 E.	0		9.0				9.0	9.0
		324	177	III	6.45	+0.16	6.61	-0.02	6.59	6.54
		„	„	IV	6.3	+0.21	6.51	-0.01	6.50	
107.	Juni 17	65 21	172							
	10.0 p.m.	10 44 E.	0		9.0				9.0	9.0
		18	10	III	7.7	+0.19	7.89		7.89	7.9
		55	30	IV	5.1	+0.18	5.28		5.28	5.3
		91	50	VII	6.0	+0.09	6.09	-0.01	6.08	6.1
		183	100	VI	5.8	+0.27	6.07	-0.01	6.06	6.1
		315	172	III	6.1	+0.21	6.31	-0.01	6.30	6.24
		„	„	IV	6.0	+0.20	6.20	-0.01	6.19	
108.	Juni 18	66 6	127							
	4.30 a.m.	11 1 E.	0		7.3				7.3	7.3
		232	127	III	5.9	+0.21	6.11	-0.01	6.10	6.04
		„	„	IV	5.8	+0.20	6.00	-0.01	5.99	
109.	Juni 18	66 10	180							
	7.0 a.m.	10 41 E.	0		8.4				8.4	8.4
		37	20	III	7.2	+0.22	7.42		7.42	7.4
		73	40	III	6.5	+0.22	6.72		6.72	6.7
		329	180	III	6.0	+0.16	6.16	-0.02	6.14	6.16
		„	„	IV	6.0	+0.20	6.20	-0.01	6.19	
110.	Juni 18	66 12	159							
	9.0 a.m.	10 30 E.	0		8.4				8.4	8.4
		291	159	III	6.0	+0.16	6.16	-0.02	6.14	6.16
		„	„	IV	6.0	+0.20	6.20	-0.01	6.19	
111.	Juni 18	66 15	157							
	10.30 a.m.	10 21 E.	0		8.5				8.5	8.5
		287	157	IV	6.0	+0.20	6.20	-0.01	6.19	6.2
112.	Juni 18	66 16	138							
	0.15 p.m.	10 10 E.	0		8.3				8.3	8.3
		252	138	III	6.05	+0.21	6.26	-0.01	6.25	6.25
113.	Juni 18	66 18	123							
	2.0 p.m.	10 0 E.	0		7.1				7.1	7.1
		225	123	III	6.0	+0.21	6.21	-0.01	6.20	6.2
114.	Juni 18	66 18	120							
	3.40 p.m.	9 51 E.	0		7.2				7.2	7.2
		219	120	III	6.0	+0.21	6.21	-0.01	6.20	6.2
115.	Juni 18	66 20	132							
	5.0 p.m.	9 41 E.	0		7.1				7.1	7.1
		241	132	III	6.0	+0.21	6.21	-0.01	6.20	6.2
116.	Juni 18	66 21	121							
	6.30 p.m.	9 30 E.	0		7.5				7.5	7.5
		221	121	III	6.0	+0.21	6.21	-0.01	6.20	6.2
117.	Juni 18	66 23	141							
	7.45 p.m.	9 20 E.	0		8.0				8.0	8.0
		258	141	III	6.0	+0.21	6.21	-0.01	6.20	6.2
118.	Juni 18	66 26	141							
	10.30 p.m.	8 59 E.	0		8.0				8.0	8.0
		258	141	III	6.0	+0.21	6.21	-0.01	6.20	6.2
119.	Juni 19	66 28	168							
	0.45 a.m.	8 40 E.	0		8.0				8.0	8.0
		307	168	III	6.0	+0.21	6.21	-0.02	6.19	6.2
120.	Juni 19	66 30	190							
	2.30 a.m.	8 20 E.	0		8.0				8.0	8.0
		347	190	III	6.0	+0.21	6.21	-0.02	6.19	6.2

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′								
121.	Juni 19	66 33	192		°				°	°
	4.25 a.m.	7 59 E.	0		7.0	°	°	°	7.0	7.0
		351	192	III	4.6	+0.20	4.80	-0.01	4.79	4.83
		„	„	IV	4.7	+0.17	4.87	-0.01	4.86	
122.	Juni 19	66 36	201							
	6.30 a.m.	7 40 E.	0		8.1				8.1	8.1
		368	201	III	4.8	+0.20	5.00	-0.02	4.98	4.92
		„	„	IV	4.7	+0.17	4.87	-0.01	4.86	
123.	Juni 19	66 39	246							
	8.30 a.m.	7 19 E.	0		8.1				8.1	8.1
		450	246	III	5.4	+0.20	5.60	-0.02	5.58	5.57
		„	„	IV	5.4	+0.19	5.59	-0.02	5.57	
124.	Juni 19	66 41	350							
	10.0 a.m.	6 59 E.	0		8.4				8.4	8.4
		37	20	VII	7.8	+0.07	7.87		7.87	7.9
		91	50	VI	7.3	+0.30	7.60	-0.01	7.59	7.6
		183	100	VI	7.0	+0.30	7.30	-0.01	7.29	7.3
		366	200	III	6.3	+0.22	6.52	-0.02	6.50	6.5
		549	300	IV	2.8	+0.12	2.92	-0.02	2.90	2.9
		640	350	III	-1.0	+0.15	-0.85	-0.02	-0.83	-0.90
		„	„	IV	-1.0	+0.02	-0.98	-0.02	-0.96	
125.	Juni 20	67 52	700							
	8.0 a.m.	5 12 E.	0		7.1				7.1	7.1
		183	100	I	5.5	+0.07	5.57	-0.02	5.55	5.6
		366	200	VII	4.7	+0.10	4.80	-0.02	4.78	4.8
		549	300	VI	2.7	+0.19	2.89	-0.03	2.86	2.9
		732	400	IV	0.05	+0.05	0.10	-0.03	0.07	0.1
		914	500	III	-0.8	+0.05	-0.75	-0.05	-0.80	-0.8
		1280	700	III	-1.1	+0.04	-1.06	-0.07	-1.13	-1.13
		„	„	IV	-1.1	+0.02	-1.08	-0.05	-1.13	
126.	Juni 20	67 49	730							
	11.15 a.m.	5 33 E.	0		7.0				7.0	7.0
		1335	730	III	-1.1	+0.04	-1.06	-0.07	-1.13	-1.13
		„	„	IV	-1.1	+0.02	-1.08	-0.05	-1.13	
127.	Juni 20	67 47	715							
	1.0 p.m.	5 54 E.	0		7.0				7.0	7.0
		1308	715	III	-1.1	+0.04	-1.06	-0.07	-1.13	-1.13
		„	„	IV	-1.1	+0.02	-1.08	-0.05	-1.13	
128.	Juni 20	67 43	688							
	2.40 p.m.	6 21 E.	0		7.0				7.0	7.0
		1258	688	III	-1.15	+0.04	-1.11	-0.07	-1.18	-1.18
		„	„	IV	-1.15	+0.02	-1.13	-0.05	-1.18	
129.	Juni 20	67 40	709							
	4.30 p.m.	6 42 E.	0		6.8				6.8	6.8
		1296	709	III	-1.15	+0.04	-1.11	-0.07	-1.18	-1.15
		„	„	IV	-1.15	+0.02	-1.13	-0.05	-1.18	
		„	„	B	231.5		-2.10	+1.00	-1.10	
130.	Juni 20	67 38	689							
	6.15 p.m.	7 3 E.	0		6.8				6.8	6.8
		1260	689	III	-1.12	+0.04	-1.08	-0.07	-1.15	-1.11
		„	„	IV	-1.05	+0.02	-1.03	-0.05	-1.08	
131.	Juni 20	67 35	795							
	8.0 p.m.	7 26 E.	0		7.8				7.8	7.8
		1454	795	III	-1.2	+0.04	-1.16	-0.08	-1.24	-1.24
		„	„	IV	-1.2	+0.02	-1.18	-0.06	-1.24	
132.	Juni 20	67 33	954							
	10.0 p.m.	7 48 E.	0		8.0				8.0	8.0
		1745	954	I	-1.2	+0.11	-1.09	-0.18	-1.27	-1.19
		„	„	III	-1.1	+0.04	-1.06	-0.09	-1.15	
		„	„	IV	-1.1	+0.02	-1.08	-0.07	-1.15	
133.	Juni 20	67 30	890							
	12.0 p.m.	8 10 E.	0		7.7				7.7	7.7
		1628	890	I	-1.3	+0.11	-1.19	-0.16	-1.35	-1.28
		„	„	III	-1.15	+0.04	-1.11	-0.09	-1.20	
134.	Juni 21	67 29	878							
	1.40 a.m.	8 20 E.	0		6.9				6.0	6.9
		1606	878	I	-1.1	+0.11	-0.99	-0.16	-1.15	-1.15
		„	„	III	-1.1	+0.04	-1.06	-0.09	-1.15	
135.	Juni 21	67 27	860							
	3.0 a.m.	8 31 E.	0		6.4				6.4	6.4
		1573	860	III	-1.1	+0.04	-1.06	-0.09	-1.15	-1.15
136.	Juni 21	67 25	610							
	4.45 a.m.	8 47 E.	0		8.3				8.3	8.3
		1116	610	III	-1.1	+0.04	-1.06	-0.06	-1.12	-1.1

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1877	° '			°	°	°	°	°	°
137.	Juni 21	67 24	452							
	6.0 a.m.	8 58 E.	0		8.2				8.2	8.2
		91	50	VI	7.3	+0.30	7.60		7.60	7.6
		183	100	I	6.9	+0.06	6.96	-0.02	6.94	6.9
		366	200	VII	5.9	+0.09	5.99	-0.02	5.97	6.0
		549	300	IV	5.0	+0.18	5.18	-0.02	5.16	5.2
		732	400	III	-1.0	+0.05	-0.95	-0.04	-0.99	-1.0
		827	452	III	-1.0	+0.05	-0.95	-0.05	-1.00	-1.0
138.	Juni 21	67 18	184							
	5.30 p.m.	9 9 E.	0		8.2				8.2	8.2
		336	184	III	5.9	+0.16	6.06	-0.02	6.04	6.01
		"	"	IV	5.8	+0.20	6.00	-0.01	5.99	
139.	Juni 21	67 14	175							
	6.45 p.m.	9 25 E.	0		8.2				8.2	8.2
		320	175	III	6.05	+0.16	6.21	-0.02	6.19	6.19
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
140.	Juni 21	67 10	197							
	8.30 p.m.	9 42 E.	0		8.2				8.2	8.2
		360	197	III	6.05	+0.16	6.21	-0.02	6.19	6.19
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
141.	Juni 21	67 6	192							
	9.40 p.m.	9 59 E.	0		8.2				8.2	8.2
		351	192	III	6.05	+0.16	6.21	-0.02	6.19	6.19
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
142.	Juni 21	67 2	178							
	11.0 p.m.	10 17 E.	0		8.3				8.3	8.3
		326	178	III	6.05	+0.16	6.21	-0.02	6.19	6.16
		"	"	IV	5.95	+0.20	6.15	-0.01	6.14	
143.	Juni 22	66 58	189							
	0.15 a.m.	10 33 E.	0		8.2				8.2	8.2
		346	189	III	6.1	+0.16	6.26	-0.02	6.24	6.21
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
144.	Juni 22	66 53	183							
	1.45 a.m.	10 50 E.	0		8.6				8.6	8.6
		335	183	III	6.0	+0.16	6.16	-0.02	6.14	6.17
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
145.	Juni 22	66 49	198							
	3.0 a.m.	11 7 E.	0		8.0				8.0	8.0
		18	10	III	8.2	+0.19	8.39		8.39	8.4
		55	30	IV	6.8	+0.22	7.02		7.02	7.0
		91	50	VI	6.2	+0.28	6.48	-0.01	6.47	6.5
		183	100	I	6.4	+0.06	6.46	-0.02	6.44	6.4
		274	150	VII	6.2	+0.08	6.28	-0.02	6.26	6.3
		362	198	III	5.8	+0.16	5.96	-0.02	5.94	5.91
		"	"	IV	5.7	+0.20	5.90	-0.01	5.89	
146.	Juni 22	66 45	180							
	5.45 a.m.	11 22 E.	0		8.7				8.7	8.7
		329	180	III	6.0	+0.16	6.16	-0.02	6.14	6.17
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
147.	Juni 22	66 49	142							
	8.30 a.m.	12 8 E.	0		8.5				8.5	8.5
		260	142	III	6.05	+0.16	6.21	-0.01	6.20	6.19
		"	"	IV	6.0	+0.20	6.20	-0.01	6.19	
148.	Juni 22	67 27	150							
	7.0 p.m.	13 25 E.	0		7.6				7.6	7.6
		18	10	IV	6.6	+0.22	6.82	+0.10	6.82	6.82
		"	"	B	204.7		6.83	+0.01	6.84	
		"	"	NZ	6.8		6.80		6.80	
		37	20	III	4.6	+0.13	4.73	0.00	4.73	4.73
		"	"	B	210.95		4.74	+0.02	4.76	
		"	"	NZ	4.7		4.70		4.70	
		55	30	III	4.05	+0.13	4.18	0.00	4.18	4.16
		"	"	B	212.7		4.15	+0.04	4.19	
		"	"	NZ	4.1		4.10		4.10	
		73	40	III	3.95	+0.12	4.07	0.00	4.07	4.03
		"	"	B	213.3		3.95	+0.06	4.01	
		"	"	NZ	4.0		4.00		4.00	
		91	50	IV	3.75	+0.15	3.90	0.00	3.90	3.89
		"	"	B	213.8		3.80	+0.07	3.87	
		"	"	NZ	3.9		3.90		3.90	
		110	60	IV	3.6	+0.14	3.74	-0.00	3.74	3.78
		"	"	B	214.0		3.71	+0.08	3.79	
		"	"	NZ	3.8		3.80		3.80	
		128	70	III	3.65	+0.12	3.77	-0.01	3.76	3.9
		"	"	B	214.0		3.71	+0.10	3.81	
		"	"	NZ	3.9		3.9		3.90	
148. f.		146	80	III	3.8	+0.12	3.92	-0.01	3.91	4.0
		"	"	B	214.0		3.71	+0.11	3.82	
		"	"	NZ	4.0		4.00		4.00	
		165	90	III	3.8	+0.12	3.92	-0.01	3.91	
		"	"	B	214.0		3.71	+0.13	3.84	
		183	100	III	3.8	+0.12	3.92	-0.01	3.91	4.3
		"	"	B	214.0		3.71	+0.14	3.85	
		"	"	NZ	4.3		4.30		4.30	
		219	120	NZ	4.6		4.60		4.60	4.6
		256	140	III	3.9	+0.12	4.02	-0.01	4.01	5.0
		"	"	NZ	5.0		5.00		5.00	
149.	Juni 23	67 52	135							
	4^h-9^h a.m.	13 58 E.	0		7.8				7.8	7.8
extra	Juni 25	Hopen	6.5							
	0.0 p.m.	Salten Fj.	0		6.9				6.9	6.9
		2	1	III	6.0	+0.16	6.16		6.16	6.2
		3	1.5	III	6.1	+0.16	6.26		6.26	6.3
		4	2	VII	6.0	+0.09	6.09		6.09	6.1
		5	3	VI	5.6	+0.26	5.86		5.86	5.9
		7	4	IV	5.5	+0.19	5.69		5.69	5.7
		9	5	I	5.5	+0.06	5.56		5.56	5.6
		12	6.5	I	5.6	+0.06	5.66		5.66	5.7
150.	Juni 26	67 11	189							
	0.20 a.m.	13 21 E.	0		8.2				8.2	8.2
151.	Juni 26	67 15	127							
	1.45 a.m.	13 4 E.	0		8.2				8.2	8.2
152.	Juni 26	67 18	125							
	3.0 a.m.	12 46 E.	0		8.2				8.2	8.2
		110	60	III	4.0	+0.13	4.13	-0.01	4.12	4.1
153.	Juni 26	67 22	122							
	4.30 a.m.	12 29 E.	0		7.7				7.7	7.7
154.	Juni 26	67 26	78							
	6.0 a.m.	12 14 E.	0		7.5				7.5	7.5
155.	Juni 28	67 35	72							
	5.25 p.m.	11 46 E.	0		8.4				8.4	8.4
		18	10	VII	7.6	+0.07	7.67		7.67	7.7
		37	20	VI	5.0	+0.25	5.25		5.25	5.3
		55	30	IV	4.7	+0.17	4.87		4.87	4.9
		73	40	III	4.3	+0.13	4.43		4.43	4.4
		91	50	I	4.3	+0.07	4.37	-0.01	4.36	4.4
		115	63	NZ	4.5		4.50		4.50	4.5
156.	Juni 28	67 40	90							
	8.10 p.m.	11 26 E.	0		8.8				8.8	8.8
		165	90	III	4.6	+0.13	4.73	-0.01	4.72	4.74
		"	"	IV	4.6	+0.17	4.77	-0.01	4.76	
157.	Juni 28	67 45	106							
	9.45 p.m.	11 7 E.	0		8.8				8.8	8.7
		194	106	III	4.7	+0.14	4.84	-0.01	4.83	4.85
		"	"	IV	4.7	+0.17	4.87	-0.01	4.86	
158.	Juni 28	67 49	102							
	11.15 p.m.	10 49 E.	0		8.7				8.7	9.0
		187	102	III	4.45	+0.13	4.58	-0.01	4.57	4.61
		"	"	IV	4.5	+0.16	4.66	-0.01	4.65	
159.	Juni 29	67 54	118							
	0.45 a.m.	10 30 E.	0		9.0				9.0	9.0
		216	118	III	4.5	+0.13	4.63	-0.01	4.62	4.64
		"	"	IV	4.5	+0.16	4.66	-0.01	4.65	
160.	Juni 29	67 58	280							
	2.15 a.m.	10 11 E.	0		9.0				9.0	9.0
		512	280	III	5.7	+0.15	5.85	-0.03	5.82	5.90
		"	"	IV	5.8	+0.20	6.00	-0.02	5.98	
161.	Juni 29	68 3	592							
	4.0 a.m.	9 53 E.	0		8.2				8.2	8.2
		91	50	VII	7.0	+0.08	7.08	-0.01	7.07	7.1
		183	100	VII	6.1	+0.09	6.19	-0.01	6.18	6.2
		366	200	VI	5.1	+0.25	5.35	-0.02	5.33	5.3
		549	300	I	3.5	+0.08	3.58	-0.05	3.53	3.5
		732	400	IV	-0.5	+0.04	-0.46	-0.03	-0.49	-0.5
		914	500	III	-1.1	+0.04	-1.06	-0.01	-1.07	-1.1
		1083	592	III	-1.1	+0.04	-1.06	-0.05	-1.11	-1.12
		"	"	IV	-1.1	+0.02	-1.08	-0.04	-1.12	

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′			°	°	°	°	°	°
162.	Juni 29	68 23	795							
	8.0 a.m.	10 20 E.	0		8.7				8.7	8.7
		1454	795	III	-1.2	+0.04	-1.16	-0.08	-1.24	-1.24
		„	„	IV	-1.2	+0.02	-1.18	-0.06	-1.24	
163.	Juni 29	68 22	690							
	9.30 a.m.	10 30 E.	0		8.7				8.7	8.7
		1262	690	I	-1.2	+0.11	-1.09	-0.13	-1.22	-1.22
		„	„	III	-1.2	+0.04	-1.16	-0.07	-1.23	
164.	Juni 29	68 21	457							
	10.50 a.m.	10 40 E.	0		9.2				9.2	9.2
		836	457	I	-0.7	+0.11	-0.59	-0.10	-0.69	-0.70
		„	„	III	-0.7	+0.05	-0.65	-0.06	-0.71	
165.	Juni 29	68 46	1470							
	11.0 p.m.	10 51 E.	0		8.2				8.2	8.2
		1746	955	B	232.6		-2.48	+1.35	-1.13	-1.1
		2688	1470	III	-1.1	+0.04	-1.06	-0.15	-1.21	-1.2
166.	Juni 30	68 40	406							
	3.30 a.m.	11 40 E.	0		8.1				8.1	8.1
		742	406	III	0.1	+0.06	0.16	-0.04	0.12	0.1
167.	Juni 30	68 37	79							
	5.30 a.m.	12 2 E.	0		8.6				8.6	8.6
		144	79	III	6.2	+0.16	6.36	-0.01	6.35	6.43
		„	„	IV	6.3	+0.21	6.51	-0.01	6.50	
168.	Juni 30	68 39	444							
	6.25 a.m.	11 51 E.	0		8.6				8.6	8.6
		91	50	I	6.6	+0.06	6.66		6.66	6.7
		183	100	VII	6.4	+0.08	6.48	-0.01	6.47	6.5
		366	200	VI	5.2	+0.25	5.45	-0.02	5.43	5.4
		549	300	III	3.4	+0.18	3.58	-0.03	3.55	3.6
		732	400	IV	2.2	+0.10	2.30	-0.03	2.27	2.3
		812	444	III	2.2	+0.10	2.30	-0.04	2.26	2.27
		„	„	IV	2.2	+0.10	2.30	-0.03	2.27	
169.	Juni 30	68 36	72							
	11.37 a.m.	12 53 E.	0		8.4				8.4	8.4
		132	72	III	5.2	+0.14	5.34	-0.01	5.33	5.35
		„	„	IV	5.2	+0.18	5.38	-0.01	5.37	
170.	Juni 30	68 32	67							
	1.45 p.m.	13 18 E.	0		8.9				8.9	8.9
		123	67	I	5.1	+0.07	5.07	-0.01	5.06	5.22
		„	„	IV	5.2	+0.18	5.38	-0.01	5.37	
171.	Juli 2	69 18	642							
	2.45 p.m.	14 29 E.	0		9.0				9.0	9.0
		1174	642	III	-1.0	+0.04	-0.96	-0.06	-1.02	-0.95
		„	„	B	230.5		-1.78	+0.90	-0.88	
172.	Juli 2	69 12	81							
	4.45 p.m.	14 47 E.	0		9.1				9.1	9.1
		37	20	IV	5.0	+0.18	5.18		5.18	5.2
		91	50	III	5.1	+0.14	5.24		5.24	5.2
		148	81	III	5.2	+0.15	5.35	-0.01	5.34	5.30
		„	„	IV	5.1	+0.18	5.28	-0.01	5.27	
173.	Juli 2	69 14	240							
	5.30 p.m.	14 43 E.	0		9.0				9.0	9.0
		439	240	III	5.2	+0.15	5.35	-0.03	5.32	5.34
		„	„	IV	5.2	+0.18	5.38	-0.02	5.36	
174.	Juli 2	69 16	337							
	6.15 p.m.	14 38 E.	0		8.9				8.9	8.9
		616	337	III	4.0	+0.12	4.12	-0.04	4.08	4.15
		„	„	IV	4.1	+0.15	4.25	-0.03	4.22	
175.	Juli 2	69 17	415							
	6.50 p.m.	14 35 E.	0		9.0				9.0	9.0
		759	415	III	2.9	+0.11	3.01	-0.04	2.97	3.01
		„	„	IV	2.95	+0.13	3.08	-0.03	3.05	
176.	Juli 2	69 18	536							
	11.20 p.m.	14 33 E.	0		8.0				8.0	8.0
		91	50	I	5.8	+0.06	5.86		5.86	5.9
		183	100	VII	6.0	+0.09	6.09	-0.01	6.08	6.1
		366	200	VI	5.5	+0.26	5.76	-0.02	5.74	5.7
		549	300	IV	4.3	+0.16	4.46	-0.02	4.44	4.4
		732	400	III	3.25	+0.11	3.36	-0.04	3.32	3.3
		980	536	III	-0.3	+0.06	-0.24	-0.04	-0.28	-0.23
		„	„	B	228.0		-0.94	+0.75	-0.19	

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′			°	°	°	°	°	°
177.	Juli 3	69 25	1443							
	4.30 p.m.	13 49 E.	0		9.8				9.8	9.8
		2639	1443	III	-1.1	+0.04	-1.06	-0.14	-1.20	-1.19
		„	„	IV	-1.1	+0.02	-1.08	-0.11	-1.19	
178.	Juli 4	69 29	1578							
	5.10 a.m.	12 26 E.	0		8.8				8.8	8.8
		2886	1578	III	-1.1	+0.04	-1.06	-0.16	-1.22	-1.32
		„	„	IV	-1.3	+0.01	-1.29	-0.12	-1.41	
179.	Juli 4	69 32	1607							
	10.30 a.m.	11 10 E.	0		8.8				8.8	8.8
		2939	1607	III	-1.05	+0.04	-1.01	-0.16	-1.17	-1.21
		„	„	IV	-1.1	+0.02	-1.08	-0.12	-1.20	
		„	„	B	235.8		-3.55	+2.28	-1.27	
180.	Juli 4	69 39	1594							
	3.0 p.m.	9 55 E.	0		8.0				8.0	8.0
		2915	1594	IV	-1.1	+0.02	-1.08	-0.12	-1.20	-1.35
		„	„	B	236.4		-3.76	+2.25	-1.51	
181.	Juli 4	69 45	1595							
	8.0 p.m.	8 43 E.	0		8.9				8.9	8.9
		2917	1595	III	-1.1	+0.04	-1.06	-0.16	-1.22	-1.24
		„	„	IV	-1.15	+0.02	-1.13	-0.12	-1.25	
182.	Juli 5	69 51	1684							
	1.0 a.m.	7 30 E.	0		8.5				8.5	8.5
		3080	1684	III	-1.15	+0.04	-1.11	-0.17	-1.28	-1.21
		„	„	IV	-1.05	+0.02	-1.03	-0.12	-1.15	
183.	Juli 5	69 59	1710							
	5.30 a.m.	6 15 E.	0		8.6				8.6	8.6
		37	20	VI	6.0	+0.27	6.27		6.27	6.3
		91	50	I	5.2	+0.07	5.27	-0.01	5.26	5.3
		183	100	III	4.7	+0.14	4.84	-0.01	4.83	4.8
		274	150	IV	4.1	+0.15	4.25	-0.01	4.24	4.2
		366	200	VII	3.9	+0.10	4.00	-0.02	3.98	4.0
		549	300	VI	3.2	+0.20	3.40	-0.03	3.37	3.4
		732	400	I	2.7	+0.09	2.79	-0.08	2.71	2.7
		914	500	III	1.2	+0.08	1.28	-0.05	1.23	1.2
		1097	600	IV	0.0	+0.05	0.05	-0.05	0.00	0.0
		1463	800	VI	-0.8	+0.10	-0.70	-0.09	-0.79	-0.8
		1829	1000	IV	-0.9	+0.02	-0.88	-0.08	-0.96	-1.0
		2195	1200	III	-1.0	+0.05	-0.95	-0.12	-1.07	-1.1
		2560	1400	I	-1.05	+0.11	-0.94	-0.26	-1.20	-1.2
		3127	1710	III	-1.1	+0.04	-1.06	-0.17	-1.23	-1.27
		„	„	IV	-1.2	+0.02	-1.18	-0.12	-1.30	
184.	Juli 6	70 4	1547							
	10.0 a.m.	9 50 E.	0		7.6				7.6	7.6
		183	100	I	3.85	+0.08	3.93	-0.01	3.92	3.9
		366	200	VI	3.2	+0.20	3.40	-0.02	3.38	3.4
		732	400	IV	2.5	+0.11	2.61	-0.03	2.58	2.6
		914	500	VII	1.4	+0.13	1.53	-0.05	1.48	1.5
		1097	600	III	0.0	+0.06	0.06	-0.06	0.00	0.0
		2829	1547	III	-1.1	+0.04	-1.06	-0.15	-1.21	-1.25
		„	„	IV	-1.1	+0.02	-1.08	-0.11	-1.19	
		„	„	B	235.8		-3.55	+2.19	-1.36	
185.	Juli 6	70 3	1485							
	11.0 p.m.	13 37 E.	0		8.8				8.8	8.8
		2716	1485	III	-1.1	+0.04	-1.06	-0.15	-1.21	-1.38
		„	„	IV	-1.45	+0.01	-1.44	-0.11	-1.55	
186.	Juli 7	69 56	1418							
	2.0 a.m.	14 18 E.	0		8.0				8.0	8.0
		2593	1418	III	-1.1	+0.04	-1.06	-0.14	-1.20	-1.27
		„	„	IV	-1.25	+0.02	-1.23	-0.10	-1.33	
187.	Juli 7	69 51	1335							
	4.35 a.m.	14 41 E.	0		8.5				8.5	8.5
		2441	1335	III	-1.0	+0.05	-0.95	-0.14	-1.09	-1.14
		„	„	IV	-1.1	+0.02	-1.08	-0.10	-1.18	
188.	Juli 7	69 43	1185							
	9.15 a.m.	15 29 E.	0		9.0				9.0	9.0
		2167	1185	I	-1.25	+0.11	-1.14	-0.22	-1.36	-1.31
		„	„	IV	-1.2	+0.02	-1.18	-0.09	-1.27	
189.	Juli 7	69 41	860							
	11.0 a.m.	15 42 E.	0		9.6				9.6	9.6
		1573	860	I	-1.15	+0.11	-1.04	-0.16	-1.20	-1.12
		„	„	III	-1.0	+0.05	-0.95	-0.09	-1.04	

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′			°	°	°	°	°	°
190.	Juli 7	69 41	870							
	0.35 p.m.	15 51 E.	0		9.4				9.4	9.4
		1591	870	I	-1.2	+0.11	-1.09	-0.16	-1.25	-1.18
		„	„	III	-1.05	+0.04	-1.01	-0.09	-1.10	
191.	Juli 7	69 44	249							
	8.40 p.m.	16 26 E.	0		9.0				9.0	9.0
		455	249	III	5.1	+0.14	5.24	-0.03	5.21	5.24
		„	„	IV	5.1	+0.18	5.28	-0.02	5.26	
192.	Juli 7	69 46	649							
	9.45 p.m.	16 15 E.	0		9.2				9.2	9.2
		1187	649	III	-0.7	+0.05	-0.65	-0.06	-0.71	-0.66
		„	„	IV	-0.6	+0.03	-0.57	-0.05	-0.62	
193.	Juli 8	69 44	46							
	4.15 a.m.	16 54 E.	0		7.5				7.5	7.5
		84	46	III	5.3	+0.20	5.50		5.50	5.5
194.	Juli 8	69 43	29							
	5.35 a.m.	17 16 E.	0		8.9				8.9	8.9
		53	29	III	5.2	+0.20	5.40		5.40	5.4
195.	Juli 16	70 55	107							
	7.30 p.m.	18 38 E.	0		6.0				6.0	6.0
		196	107	III	5.0	+0.14	5.14	-0.01	5.13	5.09
		„	„	IV	4.9	+0.17	5.07	-0.01	5.06	
196.	Juli 16	71 2	122							
	11.45 p.m.	18 3 E.	0		7.8				7.8	7.8
		223	122	III	5.0	+0.14	5.14	-0.01	5.13	5.09
		„	„	IV	4.9	+0.17	5.07	-0.01	5.06	
197.	Juli 17	71 7	138							
	1.50 a.m.	17 28 E.	0		6.2				6.2	6.2
		252	138	IV	5.0	+0.18	5.18	-0.01	5.17	5.2
198.	Juli 17	71 13	226							
	4.0 a.m.	16 52 E.	0		6.0				6.0	6.0
		413	226	III	3.6	+0.19	3.79	-0.02	3.77	3.8
199.	Juli 17	71 18	525							
	6.0 a.m.	16 17 E.	0		8.2				8.2	8.2
		37	20	IV	6.3	+0.21	6.51		6.51	6.5
		91	50	III	5.75	+0.21	5.96		5.96	6.0
		183	100	VII	5.2	+0.10	5.30	-0.01	5.29	5.3
		366	200	VI	3.7	+0.21	3.91	-0.02	3.89	3.9
		549	300	IV	2.8	+0.12	2.92	-0.02	2.90	2.9
		732	400	III	1.8	+0.09	1.89	-0.03	1.86	1.9
		960	525	III	-0.5	+0.05	-0.45	-0.05	-0.50	-0.56
		„	„	IV	-0.6	+0.03	-0.57	-0.04	-0.61	
200	Juli 17	71 25	620							
	10.0 a.m.	15 41 E.	0		7.8				7.8	7.8
		1134	620	III	-0.95	+0.05	-0.90	-0.06	-0.96	-0.97
		„	„	IV	-0.95	+0.02	-0.93	-0.05	-0.98	
201.	Juli 17	71 31	647							
	10.30 p.m.	15 28 E.	0		8.0				8.0	8.0
		1183	647	III	0.0	+0.05	-0.95	-0.07	-1.02	-1.08
		„	„	IV	0.1	+0.02	-1.08	-0.05	-1.13	
202.	Juli 18	71 31	803							
	1.0 a.m.	14 40 E.	0		7.0				7.0	7.0
		1468	803	III	-1.0	+0.05	-0.95	-0.08	-1.03	-1.06
		„	„	IV	-1.05	+0.02	-1.03	-0.06	-1.09	
203.	Juli 18	71 31	901							
	4.0 a.m.	13 54 E.	0		7.2				7.2	7.2
		1648	901	III	-1.4	+0.04	-1.36	-0.09	-1.45	-1.46
		„	„	IV	-1.4	+0.01	-1.39	-0.07	-1.46	
204.	Juli 18	70 57	1266							
	10.30 a.m.	13 34 E.	0		7.8				7.8	7.8
		2315	1266	III	-1.0	+0.05	-0.95	-0.13	-1.08	-1.10
		„	„	IV	-1.05	+0.02	-1.03	-0.09	-1.12	
205.	Juli 18	70 51	1287							
	10.0 p.m.	13 3 E.	0		7.6				7.6	7.6
		2354	1287	III	-1.15	+0.05	-1.10	-0.13	-1.23	-1.18
		„	„	IV	-1.05	+0.02	-1.03	-0.10	-1.13	

No. 201. Bundtemp. sandsynligvis aflæst 1° for højt. Se No. 294
Bottom-Temp. probably read 1° too high. See No. 294.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′			°	°	°	°	°	°
206.	Juli 19	70 45	1248							
	1.15 p.m.	14 36 E.	0		8.2				8.2	8.2
		183	100	III	4.2	+0.20	4.40	-0.01	4.39	4.4
		549	300	IV	3.0	+0.13	3.13	-0.02	3.11	3.1
		914	500	VI	0.6	+0.14	0.74	-0.06	0.68	0.7
		1280	700	VII	-0.8	+0.15	-0.65	-0.07	-0.72	-0.7
		1734	948	VI	-1.0	+0.10	-0.90	-0.11	-1.01	-1.0
		2282	1248	III	-1.1	+0.04	-1.06	-0.12	-1.18	-1.12
		„	„	IV	-1.0	+0.02	-0.98	-0.09	-1.07	
207.	Juli 19	70 33	1111							
	10.0 p.m.	15 50 E.	0		8.0				8.0	8.0
		2032	1111	III	-1.1	+0.04	-1.06	-0.11	-1.17	-1.14
		„	„	IV	-1.05	+0.02	-1.03	-0.08	-1.11	
208.	Juli 20	70 21	675							
	5.30 a.m.	16 57 E.	0		8.0				8.0	8.0
		1234	675	III	-1.0	+0.05	-0.95	-0.07	-1.02	-0.97
		„	„	IV	-0.9	+0.02	-0.88	-0.05	-0.93	
209.	Juli 20	70 19	126							
	8.45 a.m.	17 9 E.	0		8.0				8.0	8.0
		230	126	III	5.0	+0.14	5.14	-0.01	5.13	5.20
		„	„	IV	5.1	+0.18	5.28	-0.01	5.27	
210.	Juli 20	70 17	137							
	10.0 a.m.	17 20 E.	0		7.8				7.8	7.8
		251	137	III	5.8	+0.15	5.95	-0.01	5.94	5.97
		„	„	IV	5.8	+0.20	6.00	-0.01	5.99	
211.	Juli 20	70 15	129							
	11.0 a.m.	17 31 E.	0		7.6				7.6	7.6
		37	20	I	6.8	+0.06	6.86		6.86	6.9
		91	50	VII	5.75	+0.09	5.84	-0.01	5.83	5.8
		183	100	VI	5.5	+0.26	5.76	-0.01	5.75	5.8
		236	129	III	5.8	+0.15	5.95	-0.01	5.94	5.97
		„	„	IV	5.8	+0.20	6.00	-0.01	5.99	
212.	Juli 20	70 12	142							
	0.0 p.m.	17 41 E.	0		7.2				7.2	7.2
		260	142	III	5.6	+0.15	5.75	-0.01	5.74	5.76
		„	„	IV	5.6	+0.19	5.79	-0.01	5.78	
213.	Juli 26	70 23	1760							
	2.0 a.m.	2 30 E.	0		8.2				8.2	8.0
		0	„		7.8				7.8	
		37	20	III	7.6	+0.23	7.83		7.83	7.8
		91	50	IV	5.3	+0.19	5.49		5.49	5.5
		183	100	VII	4.7	+0.10	4.80	-0.01	4.79	4.8
		274	150	VI	4.0	+0.22	4.22	-0.02	4.20	4.2
		366	200	I	3.7	+0.08	3.78	-0.04	3.74	3.7
		549	300	VII	3.4	+0.11	3.51	-0.03	3.48	3.5
		732	400	VI	2.9	+0.19	3.09	-0.05	3.04	3.0
		914	500	I	2.1	+0.09	2.19	-0.09	2.10	2.1
		1097	600	IV	0.6	+0.07	0.67	-0.05	0.62	0.6
		1280	700	III	-0.2	+0.06	-0.14	-0.07	-0.21	-0.2
		3219	1760	III	-1.05	+0.04	-1.01	-0.18	-1.19	-1.17
		„	„	IV	-1.0	+0.02	-0.98	-0.13	-1.11	
		„	„	B	236.2		-3.71	+2.49	-1.22	
214.	Juli 26	70 39	1750							
	11.30 p.m.	0 0 E.	0		8.0				8.0	8.0
		3200	1750	III	-1.1	+0.04	-1.06	-0.17	-1.23	-1.19
		„	„	IV	-1.05	+0.02	-1.03	-0.13	-1.16	
215.	Juli 27	70 53	1665							
	7.30 a.m.	2 0 W.	0		8.0				8.0	8.0
		37	20	III	6.3	+0.21	6.51		6.51	6.5
		91	50	VI	4.3	+0.23	4.53	-0.01	4.52	4.5
		183	100	IV	3.5	+0.14	3.64	-0.01	3.63	3.6
		366	200	I	2.7	+0.09	2.79	-0.04	2.75	2.8
		549	300	I	2.1	+0.09	2.19	-0.06	2.13	2.1
		732	400	VII	0.8	+0.13	0.93	-0.04	0.89	0.9
		914	500	VI	0.1	+0.12	0.22	-0.06	-0.16	-0.2
		1097	600	IV	-0.4	+0.04	-0.36	-0.05	-0.41	-0.4
		1280	700	III	-0.7	+0.16	-0.54	-0.07	-0.61	-0.6
		3045	1665	III	-1.1	+0.04	-1.06	-0.17	-1.23	-1.21
		„	„	IV	-1.1	+0.02	-1.08	-0.12	-1.20	
216.	Juli 27	70 58	1231							
	3.0 p.m.	3 40 W.	0		8.2				8.2	8.2
		2251	1231	III	-1.3	+0.04	-1.26	-0.12	-1.38	-1.32
		„	„	IV	-1.2	+0.02	-1.18	-0.09	-1.27	

7*

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1877	° ′								
217.	Juli 27	71 0	829		°				°	°
	7.0 p.m.	5 9 W.	0		4.6	°	°		4.6	4.6
		9	5	III	4.7	+0.14	4.84		4.84	4.8
		18	10	VI	3.55	+0.21	3.76		3.76	3.8
		27	15	IV	0.95	+0.08	1.03		1.03	1.0
		37	20	VI	-0.65	+0.11	-0.54		-0.54	-0.5
		46	25	I	-1.35	+0.10	-1.25		-1.25	-1.3
		55	30	III	-1.8	+0.03	-1.77		-1.77	-1.8
		91	50	IV	-1.75	+0.00	-1.75	°	-1.75	-1.8
		146	80	VII	-1.6	+0.16	-1.44	-0.01	-1.45	-1.5
		183	100	VII	-1.2	+0.15	-1.05	-0.01	-1.06	-1.1
		366	200	IV	-1.15	+0.02	-1.13	-0.01	-1.14	-1.1
		549	300	III	-1.3	+0.04	-1.26	-0.03	-1.29	-1.3
		732	400	VI	-1.1	+0.10	-1.00	-0.05	-1.05	-1.1
		914	500	I	-1.3	+0.11	-1.19	-0.09	-1.28	-1.3
		1150	629	I	-1.2	+0.11	-1.09	-0.11	-1.20	-1.2
		1516	829	III	-1.3	+0.04	-1.26	-0.08	-1.34	-1.29
		„	„	IV	-1.2	+0.02	-1.18	-0.06	-1.24	
218.	Juli 27	71 1	968							
	11.0 p.m.	6 0 W.	0		3.6				3.6	3.6
		9	5	VII	3.1	+0.11	3.21		3.21	3.2
		18	10	VII	1.4	+0.13	1.53		1.53	1.5
		27	15	VI	0.7	+0.14	0.84		0.84	0.8
		37	20	I	0.9	+0.10	1.00		1.00	1.0
		46	25	VI	-0.1	+0.12	-0.02		-0.02	0.0
		55	30	I	-1.0	+0.11	-0.89		-0.89	-0.9
		1770	968	III	-1.3	+0.04	-1.26	-0.10	-1.36	-1.34
		„	„	IV	-1.3	+0.02	-1.28	-0.07	-1.35	
		„	„	B	233.1		-2.66	+1.36	-1.30	
219.	Juli 28	71 2	796							
	2.15 a.m.	6 51 W.	0		3.7				3.7	3.7
		9	5	I	3.6	+0.08	3.68		3.68	3.7
		18	10	IV	1.0	+0.08	1.08		1.08	1.1
		27	15	VI	-0.6	+0.10	-0.50		-0.50	-0.5
		37	20	VII	-1.2	+0.15	-1.05		-1.05	-1.1
		46	25	IV	-1.2	+0.02	-1.18		-1.18	-1.2
		1456	796	III	-1.2	+0.04	-1.16	-0.08	-1.24	-1.20
		„	„	B	232.0		-2.28	+1.12	-1.16	
220.	Juli 28	71 2	1275							
	10.0 a.m.	7 26 W.	0		3.0				3.0	3.0
		2332	1275	III	-1.4	+0.04	-1.36	-0.12	-1.48	-1.49
		„	„	IV	-0.7	-0.71	-1.41	-0.09	-1.50	
221.	Juli 28	71 2	1060							
	10.30 a.m.	7 35 W.	0		3.4				3.4	3.4
		18	10	IV	2.8	-0.63	2.17		2.17	2.2
		37	20	VII	0.3	+0.14	0.44		0.44	0.4
		55	30	VI	-0.8	+0.10	-0.70		-0.70	-0.7
		73	40	I	-0.6	+0.11	-0.49		-0.49	-0.5
		91	50	III	-0.7	+0.05	-0.65	-0.01	-0.66	-0.7
		128	70	III	-0.6	+0.05	-0.55	-0.01	-0.56	-0.6
		1938	1060	III	-1.25	+0.04	-1.21	-0.11	-1.31	-1.35
		„	„	IV	-0.6	-0.71	-1.31	-0.08	-1.39	
222.	Juli 28	71 2	654							
	1.0 p.m.	7 46 W.	0		3.6				3.6	3.6
		1196	654	III	-1.1	+0.04	-1.06	-0.12	-1.18	-1.02
		„	„	I	-0.9	+0.11	-0.79	-0.07	-0.86	
extra	Juli 28	71 2	144							
	2.0 p.m.	7 54 W.	0		3.8				3.8	3.8
extra	Juli 30	71 0	20							
	10.0 a.m.	8 29 W.	0		3.6				3.6	3.6
		9	5	NZ	3.2				3.2	3.2
		18	10	NZ	2.2				2.2	2.2
		27	15	NZ	2.0				2.0	2.0
		37	20	NZ	1.2				1.2	1.2
223.	Aug. 1	70 54	70							
	0.15 p.m.	8 24 W.	0		3.5				3.5	3.5
		18	10	IV	2.9	+0.12	3.02		3.02	3.0
		37	20	VII	0.2	+0.14	0.34		0.34	0.3
		55	30	VI	-0.8	+0.10	-0.70		-0.70	-0.7

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1877	° ′			°	°	°		°	°
223. f.		73	40	I	-0.7	+0.11	-0.59	°	-0.59	-0.6
		91	50	III	-0.7	+0.05	-0.65	-0.01	-0.66	-0.7
		128	70	III	-0.6	+0.05	-0.55	-0.01	-0.56	-0.6
224.	Aug. 1	70 51	95							
	6.0 p.m.	8 20 W.	0		3.4				3.4	3.4
225.	Aug. 2	70 58	195							
	10.45 a.m.	8 4 W.	0		3.4				3.4	3.4
226.	Aug. 2	70 59	340							
	2.30 p.m.	7 51 W.	0		3.0				3.0	3.0
		603	330	I	-0.4	+0.11	-0.29	-0.06	-0.35	-0.4
		622	340	III	-0.6	+0.05	-0.55	-0.03	-0.58	-0.58
		„	„	IV	-0.6	+0.04	-0.56	-0.02	-0.58	
227.	Aug. 2	71 13	1040							
	5.20 p.m.	7 33 W.	0		2.2				2.2	2.2
		55	30	NZ	-1.0				-1.0	-1.0
		1902	1040	I	-1.35	+0.11	-1.24	-0.19	-1.43	-1.49
		„	„	III	-1.5	+0.04	-1.46	-0.10	-1.56	
228.	Aug. 2	71 12	933							
	8.30 p.m.	8 9 W.	0		3.0				3.0	3.0
		1706	933	I	-1.4	+0.11	-1.29	-0.17	-1.46	-1.50
		„	„	III	-1.5	+0.04	-1.46	-0.09	-1.55	
229.	Aug. 2	71 12	732							
	11.30 p.m.	8 55 W.	0		2.8				2.8	2.8
		1339	732	I	-1.2	+0.11	-1.09	-0.13	-1.22	-1.27
		„	„	III	-1.3	+0.04	-1.26	-0.07	-1.33	
230.	Aug. 3	71 16	854							
	1.15 a.m.	9 10 W.	0		2.2				2.2	2.2
		1562	854	I	-1.2	+0.11	-1.09	-0.16	-1.25	-1.30
		„	„	III	-1.3	+0.04	-1.26	-0.09	-1.35	
231.	Aug. 3	71 21	1032							
	2.45 a.m.	9 23 W.	0		2.0				2.0	2.0
		18	10	III	1.1	+0.08	1.18		1.18	1.2
		26	14	III	-0.2	+0.06	-0.14		-0.14	-0.1
		37	20	IV	-0.7	+0.03	-0.67		-0.67	-0.7
		55	30	VII	-1.4	+0.14	-1.26		-1.26	-1.3
		73	40	VI	-1.5	+0.02	-1.48		-1.48	-1.5
		91	50	I	-1.5	+0.12	-1.38	-0.01	-1.38	-1.4
		1887	1032	III	-1.2	+0.04	-1.16	-0.10	-1.26	-1.26
		„	„	IV	-1.2	+0.02	-1.18	-0.08	-1.26	
232.	Aug. 3	71 10	780							
	6.30 a.m.	8 48 W.	0		2.8				2.8	2.8
		1426	780	III	-1.3	+0.04	-1.26	-0.08	-1.34	-1.34
		„	„	IV	-1.3	+0.02	-1.28	-0.06	-1.34	
233.	Aug. 3	71 8	580							
	7.30 a.m.	8 46 W.	0		2.6				2.6	2.6
		1061	580	III	-1.4	+0.04	-1.36	-0.06	-1.42	-1.38
		„	„	IV	-0.6	-0.71	-1.31	-0.04	-1.35	
234.	Aug. 3	71 6	259							
	8.40 a.m.	8 38 W.	0		3.8				3.8	3.8
		474	259	III	-1.0	+0.05	-0.95	-0.03	-0.98	-0.96
		„	„	VI	-1.0	+0.10	-0.90	-0.03	-0.93	
235.	Aug. 3	70 59	98							
	11.30 a.m.	8 55 W.	0		3.2				3.2	3.2
		179	98	III	-0.05	+0.06	0.01	-0.01	0.00	0.0
236.	Aug. 3	70 58	156							
	0.0 p.m.	9 2 W.	0		4.2				4.2	4.2
237.	Aug. 3	70 41	263							
	4.0 p.m.	10 10 W.	0		3.0				3.0	3.0
		18	10	VII	2.6	+0.12	2.72		2.72	2.7
		37	20	VI	1.3	+0.15	1.45		1.45	1.5
		55	30	IV	0.8	-0.72	0.08		0.08	0.1
		73	40	III	-0.7	+0.05	-0.65		-0.65	-0.6
		91	50	I	-0.6	+0.11	-0.49	-0.01	-0.50	-0.5
		481	263	I	-0.3	+0.11	-0.19	-0.05	-0.24	-0.27
		„	„	VI	-0.4	+0.11	-0.29	-0.02	-0.31	

No. 220. Loddet med 112 Punds Lod. Dybden sandsynligvis for stor. Therm. No. IV har forandret Correction.
Sounding taken with the 112-pounds lead. Depth probably too great. Therm. No. IV has changed correction.

No. 221. Therm. No. IV corr. med den forandrede Correction.
Therm. No. IV with the changed correction.

No. 233. Therm. No. IV med forandret Correction.
Therm. No. IV with the changed correction.

No. 237. Therm. No. IV med forandret Correction.
Therm. No. IV with the changed correction.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1877	° ′								
238.	Aug. 3	70 13	845		°				°	°
	11.0 p.m.	10 54 W.	0		4.0	°	°		4.0	4.0
		18	10	VII	3.5	+0.11	3.61	°	3.61	3.6
		37	20	B	220.0		1.71	+0.03	1.74	1.7
		55	30	VII	0.6	+0.14	0.74		0.74	0.7
		73	40	VI	0.25	+0.13	0.38		0.38	0.4
		91	50	I	0.3	+0.10	0.40	-0.01	0.39	0.4
		110	60	III	0.1	+0.06	0.16		0.16	0.2
		128	70	VI	0.4	+0.13	0.53		0.53	0.5
		146	80	I	0.3	+0.10	0.40		0.40	0.4
		183	100	III	0.2	+0.07	0.27	-0.01	0.26	0.3
		274	150	VII	0.2	+0.14	0.34	-0.02	0.32	0.3
		366	200	VI	0.2	+0.13	0.33	-0.02	0.31	0.3
		457	250	III	-0.05	+0.06	0.01	-0 02	-0.01	0.0
		549	300	I	-0.2	+0.10	-0.00	-0.06	-0.16	-0.2
		1545	845	I	-1.0	+0.11	-0.89	-0.16	-1.05	-1.07
		"	"	III	-1.05	+0.04	-1.01	-0.09	-1.10	
239.	Aug. 4	69 35	1050							
	6.40 a.m.	11 13 W.	0		4.4				4.4	4.4
		1920	1050	I	-1.05	+0.11	-0.94	-0.19	-1.13	-1.00
		"	"	III	-0.85	+0.05	-0.80	-0.08	-0.88	
240.	Aug. 4	69 2	1004							
	1.15 p.m.	11 26 W.	0		4.2				4.2	4.3
	9.0 p.m.	0	0		4.4				4.4	
		18	10	I	2.8	+0.09	2.89		2.89	2.9
		37	20	VII	0.0	+0.14	0.14		0.14	0.1
		55	30	B	226.0		-0.26	+0.04	-0.22	-0.2
		73	40	III	-0.2	+0.06	-0.14			
		91	50	I	-0.8	+0.11	-0.69	-0.01	-0.70	-0.7
		110	60	III	-0.2					
		"	"	I	-0.65	+0.11	-0.54	-0.01	-0.55	-0.6
		128	70	VI	0.5	-1.00	-0.50	-0.01	-0.49	-0.5
		"	"	B	227.0		-0.60	+0.09	-0.51	
		146	80	VII	-0.7	+0.15	-0.55	-0.01	-0.54	-0.5
		165	90	B	227.1		-0.63	+0.13	-0.50	-0.5
		183	100	B	227.0		-0.60	+0.14	-0.46	-0.5
		366	200	VII	-0.65	+0.15	-0.50	-0.02	-0.52	-0.5
		549	300	VI	0.5	-1.00	-0.50	-0.03	-0.53	-0.51
		"	"	I	-0.55	+0.10	-0.45	-0.06	-0.51	
		"	"	VII	-0.6	+0.15	-0.45	-0.03	-0.48	
		732	400	B	228.8		-1.20	+0.56	-0.64	-0.6
		"	"	III	-0.2					
		914	500	I	-0.9	+0.11	-0.79	-0.09	-0.88	-0.9
		1836	1004	III	-1.0	+0.04	-0.96	-0.10	-1.06	-1.06
		"	"	VI	-0.8	+0.10	-0.70	-0.12	-0.82	
241.	Aug. 5	68 41	1119							
	7.30 p.m.	10 54 W.	0		4.6				4.6	4.6
		2046	1119	I	-1.2	+0.11	-1.09	-0.21	-1.30	-1.35
		"	"	III	-1.1	+0.04	-1.06	-0.11	-1.17	
		"	"	VII	-1.6	+0.15	-1.45	-0.12	-1.57	
242.	Aug. 6	68 36	1033							
	3.30 a.m.	8 40 W.	0		5.0				5.0	5.4
		0	"		5.8				5.8	
		37	20	IV	3.5	+0.14	3.64		3.64	3.6
		91	50	B	219.6		1.86	+0.07	1.93	1.9
		183	100	VI	1.9	-1.00	0.90	-0.01	0.89	0.9
		366	200	VII	0.4	+0.14	0.54	-0.02	0.52	0.5
		549	300	III	0.0	+0.06	0.06	-0.03	0.03	0.0
		732	400	II	-0.3	+0.08	-0.22	-0.07	-0.29	-0.3
		914	500	I	-0.7	+0.11	-0.59	-0.09	-0.68	-0.7
		1889	1033	I	-1.3	+0.11	-1.19	-0.19	-1.38	-1.27
		"	"	VII	-1.2	+0.15	-1.05	-0.11	-1.16	
	1877	° ′								
243.	Aug. 6	68 32	1385		°				°	°
	0.5 p.m.	6 26 W.	0		7.8		°	°	7.8	7.8
		27	15	B	204.2	°	7.00	+0.02	7.02	7.0
		73	40	II	3.7	+0.14	3.84		3.84	3.8
		183	100	IV	2.8	+0.12	2.92	-0.01	2.91	2.9
		366	200	VI	2.1	+0.17	2.27	-0.02	2.25	2.3
		549	300	III	0.6	+0.07	0.67	-0.03	0.64	0.6
		732	400	VII	-0.03	+0.14	0.11	-0.04	0.07	0.1
		914	500	I	-0 45	+0.11	-0.34	-0.09	-0.43	-0.4
		2167	1185	IV	-1.1	+0.02	-1.08	-0.09	-1.18	-1.2
		2533	1385	I	-1.1	+0.11	-0.99	-0.26	-1.25	-1.27
		"	"	VII	-1.3	+0.15	-1.15	-0.15	-1.30	
244.	Aug. 6	68 28	1951							
	9.0 p.m.	4 17 W.	0		8.0				8.0	8.0
		3568	1951	I	-1.05	+0.11	-0.94	-0.36	-1.30	-1.28
		"	"	III	-1.1	+0.04	-1.06	-0.19	-1.25	
245.	Aug. 7	68 21	2005							
	5.0 a.m.	2 5 W.	0		9.0				9.0	9.0
		18	10	VII	8.2	+0.07	8.27		8.27	8.3
		37	20	III	7.3	+0.18	7.48		7.48	7.5
		91	50	II	5.6	+0.17	5.77	-0.01	5.76	5.8
		128	70	I	5.3	+0.07	5.37	-0.01	5.36	5.4
		183	100	B	211.0		4.71	+0.14	4.75	4.8
		274	150	IV	3.6	+0.14	3.74	-0.01	3.73	3.7
		366	200	VI	2.5	+0.18	2.68	-0.02	2.66	2.7
		549	300	I	1.0	+0.10	1.20	-0.06	1.14	1.1
		732	400	III	-0.1	+0.06	-0.04	-0.04	-0.08	-0.1
		914	500	II	-0.2	+0.08	-0.12	-0.09	-0.21	-0.2
		1097	600	VII	-0.8	+0.15	-0.65	-0.06	-0.71	-0.7
		3667	2005	I	-1.0	+0.11	-0.89	-0.37	-1.26	-1.36
		"	"	VII	-1.4	+0.15	-1.25	-0.21	-1.46	
246.	Aug. 7	68 14	1592							
	3.0 p.m.	0 6 E.	0		9.2				9.2	9.2
		2911	1592	I	-1.2	+0.11	-1.09	-0.29	-1.38	-1.34
		"	"	VII	-1.3	+0.18	-1.12	-0.17	-1.29	
		"	"	B	235.9		-3.60	+2.25	-1.35	
247.	Aug. 7	68 5	1120							
	11.45 p.m.	2 24 E.	0		9.4				9.4	9.4
		91	50	II	6.0	+0.18	6.18		6.18	6.2
		183	100	VII	5.2	+0.10	5.30	-0.01	5.29	5.3
		366	200	VI	3.55	+0.21	3.76	-0.02	3.74	3.7
		549	300	IV	2.25	+0.11	2.36	-0.02	2.34	2.3
		732	400	III	0.2	+0.07	0.27	-0.04	0.23	0.2
		914	500	I	-0.4	+0.11	-0.29	-0.09	-0.38	-0.4
		2048	1120	I	-1.1	+0.11	-0.99	-0.21	-1.20	-1.19
		"	"	VII	-1.2	+0.15	-1.05	-0.12	-1.17	
248.	Aug. 8	67 56	778							
	9.0 a.m.	4 11 E.	0		10.2				10.2	10.2
		1423	778	I	-1.3	+0.11	-1.19	-0.14	-1.33	-1.38
		"	"	III	-1.4	+0.04	-1.36	-0.08	-1.44	
249.	Aug. 9	68 12	1063							
	1.0 a.m.	6 35 E.	0		10.0				10.0	10.0
		1944	1063	I	-1.2	+0.11	-1.09	-0.20	-1.29	-1.28
		"	"	VII	-1.3	+0.15	-1.15	-0.11	-1.26	
250.	Aug. 9	68 10	1150							
	1.30 p.m.	9 20 E.	0		12.6				12.6	12.6
		2103	1150	I	-1.3	+0.11	-1.19	-0.21	-1.40	-1.43
		"	"	III	-1.4	+0.04	-1.36	-0.11	-1.47	
251.	Aug. 9	68 6	634							
	3.45 p.m.	9 44 E.	0		13.2				13.2	13.2
		1159	634	I	-1.2	+0.11	-1.09	-0.11	-1.20	-1.26
		"	"	VII	-1.4	+0.15	-1.25	-0.07	-1.32	
252.	Aug. 11									
253.	Aug. 15	Skjærsta	263							
	4.45 p.m.	Fjord.	0		13.0				13.0	13.0
		481	263	I	3.2	+0.08	3.28	-0.02	3.26	3.23
		"	"	VII	3.1	+0.11	3.21	-0.01	3.20	
253b	Aug. 17	Skjærsta	270							
	7.0 a.m.	Fjord.	0		11.4				11.4	11.4
		18	10	VI	8.4	+0.33	8.73		8.73	8.7
		37	20	II	7.6	+0.21	7.81		7.81	7.8
		55	30	IV	7.3	+0.23	7.53		7.53	7.5
		73	40	VII	6.6	+0.08	6.68		6.68	6.7
		91	50	III	5.5	+0.15	5.65		5.65	5.7
		110	60	I	4.9	+0.07	4.97	-0.01	4.96	5.0
		128	70	B	213.4		3.92	+0.10	4.02	4.0

No. 240. Therm. No. III har ikke registreret rigtigt i 40, 60 og 400 Favne. Therm. No. VI har faaet i 70 og 300 Favne forandret Correction. Bundtemperaturen, der toges 1^h 15^m p.m., synes rigtig registreret med de samme Thermometre. Temperaturrækken toges om Aftenen Kl. 9. Man se Bemerkning Side 14.

Therm. No. III has not registered correctly in 40, 60 and 400 fms. Therm. No. VI has got a new correction in 70 and 300 fms. The Bottom-Temperature, taken at 1.15 p.m., would seem correctly registered with the same thermometers. The serial temperatures were taken at 9 p.m. See Note p. 14.

No. 242. Therm. No. VI med forandret Correction.

Therm. No. VI with changed correction.

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1877	° '			°	°	°	°	°	°
253b f.		146	80	III	3.1	+0.11	3.21	-0.01	3.20	3.2
		165	90	VI	2.9	+0.20	3.10	-0.01	3.09	3.1
		183	100	II	2.9	+0.13	3.03	-0.02	3.01	3.0
		201	110	VII	3.1	+0.11	3.21	-0.01	3.20	3.2
		219	120	IV	3.0	+0.13	3.13	-0.01	3.12	3.1
		238	130	I	3.2	+0.08	3.28	-0.02	3.26	3.3
		457	250	NZ	3.4		3.40		3.40	3.4
		494	270	B	216.6		2.86	+0.38	3.24	3.2
254.	Aug. 18	67 27	143							
	2.0 p.m.	13 25 E.	0		10.0				10.0	10.0
		0	"		11.4				11.4	11.4
		18	10	III	8.9	+0.20	9.10		9.10	9.1
		37	20	I	7.1	+0.05	7.15		7.15	7.2
		55	30	IV	5.9	+0.20	6.10		6.10	6.1
		73	40	VI	5.1	+0.25	5.35		5.35	5.4
		91	50	VII	5.05	+0.10	5.15	-0.01	5.14	5.1
		110	60	II	4.4	+0.15	4.55	-0.01	4.54	4.5
		128	70	B	211.2		4.66	+0.10	4.76	4.8
		183	100	IV	4.4	+0.16	4.56			5.1
		"	"	B	211.2		4.66	+0.14	4.80	
		"	"	NZ	5.1		5.10		5.10	
		256	140	I	4.9	+0.07	4.97			5.8
		"	"	NZ	5.8		5.80		5.80	
	1878									
255.	Juni 19	68 12	341							
	4.0 p.m.	15 40 E.	0		10.7				10.7	10.7
		18	10	89	8.1	-0.04	8.06		8.06	8.1
		37	20	"	5.8	-0.09	5.71		5.71	5.7
		73	40	"	4.6	-0.12	4.48		4.48	4.5
		110	60	"	5.2	-0.11	5.09		5.09	5.1
		146	80	"	5.9	-0.09	5.81		5.81	5.8
		183	100	"	6.0	-0.09	5.91		5.91	5.9
		366	200	"	6.5	-0.08	6.42		6.42	6.4
		549	300	"	6.6	-0.07	6.53		6.53	6.5
		624	341	"	6.6	-0.07	6.53		6.53	6.5
256.	Juni 21	70 8	225							
	7.0 a.m.	23 4 E.	0		11.6				11.6	11.6
		18	10	89	7.4	-0.05	7.35		7.35	7.4
		37	20	"	5.6	-0.10	5.50		5.50	5.5
		73	40	"	5.0	-0.11	4.89		4.89	4.9
		110	60	"	3.8	-0.14	3.66		3.66	3.7
		146	80	"	3.1	-0.16	2.94		2.94	2.9
		183	100	"	2.75	-0.17	2.58		2.58	2.6
		201	110	"	2.95	-0.16	2.79		2.79	2.8
		219	120	"	3.8	-0.14	3.66		3.66	3.7
		274	150	"	4.1	-0.13	3.97		3.97	4.0
		411	225	"	4.1	-0.13	3.97		3.97	4.0
257.	Juni 21	70 4	160							
	10.15 a.m.	23 2 E.	0		11.6				11.6	11.6
		293	160	89	4.05	-0.14	3.91		3.91	3.9
258.	Juni 21	70 13	230							
	5.0 p.m.	23 3 E.	0		11.6				11.6	11.6
259.	Juni 24	70 49	80							
	10.45 a.m.	25 59 E.	0		7.1				7.1	7.1
		37	20	89	5.5	-0.10	5.40		5.40	5.4
		73	40	"	5.0	-0.11	4.89		4.89	4.9
		91	50	"	5.1	-0.11	4.99		4.99	5.0
		110	60	"	5.0	-0.11	4.89		4.89	4.9
		146	80	"	4.2	-0.13	4.07		4.07	4.1
260.	Juni 24	70 55	127							
	0.30 p.m.	26 11 E.	0		7.4				7.4	7.4
		232	127	89	3.6	-0.15	3.45		3.45	3.5
261.	Juni 25	70 47	127							
	6.0 a.m.	28 30 E.	0		7.4				7.4	7.4
		18	10	89	6.4	-0.08	6.32		6.32	6.3
		37	20	"	4.9	-0.12	4.78		4.78	4.8
		73	40	"	4.1	-0.13	3.97		3.97	4.0
		110	60	"	3.8	-0.14	3.66		3.66	3.7
		146	80	"	3.5	-0.15	3.35		3.35	3.4
		183	100	"	3.1	-0.16	2.94		2.94	2.9
		232	127	"	3.0	-0.16	2.84		2.84	2.8

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1878	° '								
262.	Juni 27	70 36	148		°				°	°
	9.45 a.m.	32 35 E.	0		5.6	°	°	°	5.6	5.6
		37	20	89	5.5	-0.10	5.40		5.40	5.4
		73	40	"	3.7	-0.14	3.56		3.56	3.6
		146	80	"	2.6	-0.17	2.43		2.43	2.4
		219	120	"	2.2	-0.18	2.02		2.02	2.0
		271	148	"	2.1	-0.18	1.92		1.92	1.9
263.	Juni 27	70 44	121							
	5.40 p.m.	34 14 E.	0		6.0				6.0	6.0
		221	121	89	2.1	-0.18	1.92		1.92	1.91
		"	"	B	219.4		1.72	+0.18	1.90	
264.	Juni 27	70 56	86							
	10.0 p.m.	35 37 E.	0		5.2				5.2	5.2
		157	86	89	2.1	-0.18	1.92		1.92	1.9
265.	Juni 28	71 18	105							
	10.30 p.m.	34 49 E.	0		4.7				4.7	4.7
		192	105	89	2.1	-0.18	1.92		1.92	1.9
266.	Juni 29	71 27	130							
	2.7 a.m.	35 39 E.	0		4.6				4.6	4.6
		37	20	89	4.2	-0.13	4.07		4.07	4.1
		73	40	"	3.8	-0.14	3.66		3.66	3.7
		110	60	"	3.0	-0.16	2.84		2.84	2.8
		146	80	"	2.6	-0.17	2.43		2.43	2.4
		183	100	"	0.9	-0.21	0.69		0.69	0.7
		238	130	"	0.8	-0.21	0.59		0.59	0.6
267.	Juni 29	71 42	148							
	7.30 a.m.	37 1 E.	0		4.1				4.1	4.1
		18	10	89	4.2	-0.13	4.07		4.07	4.1
		37	20	"	4.2	-0.13	4.07		4.07	4.1
		73	40	"	2.8	-0.17	2.63		2.63	2.6
		110	60	"	1.7	-0.19	1.51		1.51	1.5
		128	70	"	0.7	-0.21	0.49		0.49	0.5
		146	80	"	-0.3	-0.24	-0.54		-0.54	-0.5
		183	100	"	-0.5	-0.24	-0.74		-0.74	-0.7
		219	120	"	-1.0	-0.25	-1.25		-1.25	-1.3
		271	148	"	-1.2	-0.26	-1.46		-1.46	-1.43
		"	"	B	229.1		-1.60	+0.21	-1.39	
268.	Juni 29	71 36	130							
	1.25 p.m.	36 18 E.	0		4.4				4.4	4.4
		37	20	I	4.0	+0.08	4.08		4.08	4.1
		73	40	46	33.0		2.92	-0.01	2.91	2.9
		110	60	48	51.1		2.60	-0.01	2.59	2.6
		141	77	89	3.3	-0.15	3.15		3.15	
		146	80	49	27.0		1.61	-0.01	1.60	1.6
		183	100	B	223.9		0.20	+0.20	0.40	0.4
		238	130	89	-0.7	-0.25	-0.95		-0.95	-1.01
		"	"	B	228.1		-1.26	+0.19	-1.07	
269.	Juni 29	72 11	138							
	10.35 p.m.	36 40 E.	0		2.4				2.4	2.4
		37	20	89	2.0	-0.18	1.82		1.82	1.8
		73	40	"	-0.4	-0.24	-0.64		-0.64	-0.6
		252	138	"	-0.9	-0.25	-1.15		-1.15	-1.2
270.	Juni 30	72 27	136							
	9.0 a.m.	35 1 E.	0		3.6				3.6	3.6
		37	20	89	3.9	-0.14	3.76		3.76	3.8
		73	40	"	2.8	-0.16	2.64		2.64	2.6
		110	60	"	1.9	-0.19	1.71		1.71	1.7
		146	80	"	1.2	-0.20	1.00		1.00	1.0
		183	100	"	0.8	-0.21	0.59		0.59	0.6
		249	136	"	0.2	-0.23	-0.03		-0.03	0.0
271.	Juni 30	72 38	160							
	10.0 p.m.	33 50 E.	0		4.5				4.5	4.5
		293	160	89	0.95	-0.21	0.74		0.74	0.7

No. 254. Temp. i 140 Fv. bestemt ved 2 Observationer af NZ, der gave begge samme Resultat.
Temp. in 140 fms. determined by 2 obs. giving each the same result with NZ.

No. 268. I 77 Favne har Therm. 89 registreret en for høj Temperatur. Det har aabenbart vendt sig før det er accomoderet. No. 89 har registreret Bundtemperaturen paa det nærmeste rigtig, maaske lidt for høj.
In 77 fms., Therm. No. 89 has registered too high a temperature. It must obviously have turned over prior to accommodation. No. 89 has registered the Bottom-Temperature correctly — perhaps a trifle to high.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1878	° ′								
272.	Juli 1	73 11	113		°				°	°
	8.30 a.m.	33 3 E.	0		4.0	°	°	°	4.0	4.0
		37	20	89	4.0	-0.14	3.86		3.86	3.9
		73	40	"	3.1	-0.16	2.94		2.94	2.9
		110	60	"	2.9	-0.16	2.74		2.74	2.7
		146	80	"	2.8	-0.17	2.63		2.63	2.6
		183	100	"	1.9	-0.19	1.71		1.71	1.7
		207	113	"	1.7	-0.19	1.51		1.51	1.5
273.	Juli 1	73 25	197							
	5.0 p.m.	31 30 E.	0		4.9				4.9	4.9
		37	20	III	4.4	+0.27	4.67		4.67	4.7
		91	50	I	3.9	+0.08	3.98	-0.01	3.97	4.0
		128	70	46	37.0		3.51	-0.02	3.49	3.5
		183	100	B	215.9		2.93	+0.14	3.07	3.1
		238	130	48	53.0		2.90	-0.02	2.88	2.9
		293	160	49	33.8		2.69	-0.04	2.65	2.7
		360	197	89	2.4	-0.17	2.23		2.23	2.17
		"	"	49	30.2		2.13	-0.02	2.11	
274.	Juli 2	73 46	182							
	0.40 a.m.	31 16 E.	0		3.7				3.7	3.7
		18	10	89	3.8	-0.14	3.66		3.66	3.7
		37	20	III	3.2	+0.25	3.45		3.45	3.5
		91	50	I	3.1	+0 08	3.18	-0.01	3.17	3.2
		146	80	49	36.0		3.02	-0.01	3.01	3.0
		183	100	48	53.0		2.90	-0.01	2.89	2.9
		219	120	B	217.2		2.47	+0.18	2.65	2.7
		274	150	46	25.8		1.80	-0.04	1.76	1.8
		333	182	89	0.25	-0.23	0.02		0.02	0.0
275.	Juli 2	74 8	147							
	6.0 a.m.	31 12 E.	0		2.9				2.9	2.9
		37	20	89	3.0	-0.16	2.84		2.84	2.8
		73	40	"	2.9	-0.16	2.74		2.74	2.7
		110	60	"	2.8	-0.17	2.63		2.63	2.6
		146	80	"	2.6	-0.17	2.43		2.43	2.4
		183	100	"	2.3	-0.18	2.12		2.12	2.1
		219	120	"	1.2	-0.20	1.00		1.00	1.0
		269	147	"	0.2	-0.23	-0.03		-0.03	-0.2
		"	"	B	226.4		-0.65	+0.21	-0.44	
276.	Juli 2	74 5	220							
	6.30 p.m.	27 39 E.	0		4.8				4.8	4.8
		402	220	89	1.6	-0·20	1.40		1.40	1.2
		"	"	49	22.9		0.95	-0.02	0.93	
277.	Juli 2	74 3	225							
	12.0 p.m.	25 43 E.	0		4.2				4.2	4.2
		411	225	89	1.15	-0.20	0.95		0.95	0.97
		"	"	91	1.05	-0.16	0.89		0.89	
		"	"	I	1.0	+0.10	1.10	-0.04	1.06	
278.	Juli 3	74 1	230							
	5.0 p.m.	22 27 E.	0		4.2				4.2	4.2
		421	230	89	1.0	-0.21	0.79		0.79	0.90
		"	"	48	42.0		1.03	-0.03	1.00	
279.	Juli 3	74 15	79							
	11.0 p.m.	20 48 E.	0		2.4				2.4	2.4
		144	79	89	1.2	-0.20	1.00		1.00	1.00
		"	"	49	23.1		1.00	-0.01	0.99	
280.	Juli 4	74 10	35							
	7.0 p.m.	18 51 E.	0		1.2				1.2	1.2
		64	35	I	1.0	+0.10	1.10	-0.01	1.09	1.1
		"	"	89	3.25	-0.15	3.10			
281.	Juli 5	74 3	115							
	0.3 a.m.	17 18 E.	0		4.6				4.6	4.6
		37	20	48	56.9		3.55		3.55	3.6
		73	40	46	31.0		2.60	-0.01	2.59	2.6
		110	60	B	217.0		2.53	+0.08	2.61	2.6
		146	80	49	30.6		2.17	-0.01	2.16	2.2
		210	115	III	2.0	+0.23	2.23	-0.01	2.22	2.23
		"	"	48	49.1		2.25	-0.01	2.24	
	1878	° ′								
282.	Juli 5	73 53	457		°				°	°
	5.0 a.m.	15 36 E.	0		7.0	°	°	°	7.0	7.0
		836	457	I	-1.0	+0.11	-0.89	-0.08	-0.97	-0.94
		"	"	III	-1.05	+0.19	-0.86	-0.05	-0.91	
283.	Juli 5	73 47	767							
	8.30 a.m.	14 21 E.	0		7.2				7.2	7.2
		18	10	I	6.0	+0.06	6.06		6.06	6.1
		55	30	48	67.0		5.23		5.23	5.2
		91	50	B	210.7		4.68	+0.06	4.79	4.7
		128	70	46	43.1		4.48	-0.02	4.46	4.5
		183	100	49	42.0		3.98	-0.01	3.97	4.0
		274	150	I	3.0	+0.08	3.08	-0.03	3.05	3.1
		366	200	B	217.0		2.53	+0.30	2.83	2.8
		457	250	46	29.9		2.43	-0.06	2.37	2.4
		549	300	49	29.1		1.96	-0.03	1.93	1.9
		640	350	48	44.1		1.40	-0.04	1.36	1.4
		732	400	49	22.7		0.92	-0.04	0.88	0.9
		914	500	46	10.3		-0.62	-0.12	-0.50	-0.5
		1097	600	48	29.1		-1.17	-0.08	-1.09	-1.1
		1403	767	I	-1.3	+0.11	-1.19	-0.14	-1.33	-1.36
		"	"	III	-1.5	+0.18	-1.32	-0.08	-1.40	
284.	Juli 6	73 1	800							
	1.30 a.m.	12 58 E.	0		6.8				6.8	6.8
		1463	800	89	-1.0	-0.25	-1.25		-1.25	-1.26
		"	"	49	9.5		-1.19	-0.09	-1.28	
285.	Juli 6	73 6	1024							
	5.30 a.m.	11 56 E.	0		6.5				6.5	6.5
		1873	1024	89	-1.0	-0.25	-1.25		-1.25	-1.33
		"	"	III	-1.5	+0.18	-1.32	-0.10	-1.42	
286.	Juli 6	72 57	447							
	1.5 p.m.	14 32 E.	0		7.2				7.2	7.2
		817	447	89	-0.25	-0.24	-0.49		-0.49	-0.8
		"	"	46	9.6		-0.73	-0.11	-0.84	
287.	Juli 6	72 52	249							
	11.45 p.m.	15 19 E.	0		7.6				7.6	7.6
		455	249	89	3.0	-0.16	2.84		2.84	2.87
		"	"	46	33.2		2.96	-0.06	2.90	
288.	Juli 7	72 46	215							
	7.0 a.m.	17 50 E.	0		7.4				7.4	7.4
		393	215	89	2.6	-0.17	2.43		2.43	2.37
		"	"	I	2.25	+0.09	2.34	-0.04	2.30	
289.	Juli 7	72 41	219							
	0.30 p.m.	20 18 E.	0		7.6				7.6	7.6
		400	219	89	2.2	-0.18	2.02		2.02	1.99
		"	"	49	29.2		1.97	-0.02	1.95	
290.	Juli 7	72 27	191							
	3.30 p.m.	20 51 E.	0		7.6				7.6	7.6
		349	191	89	3.7	-0.14	3.56		3.56	3.5
		"	"	I	3.4	+0.08	3.48	-0.04	3.44	
291.	Juli 8	71 54	194							
	0.10 a.m.	21 57 E.	0		7.4				7.4	7.4
		37	20	I	5.8	+0.06	5.86		5.86	5.9
		73	40	III	4.7	+0.28	4.98		4.98	5.0
		"	"	48	66.0		5.06	-0.01	5.05	
		128	70	46	43.2		4.50	-0.02	4.48	4.5
		183	100	B	212.5		4.08	+0.15	4.23	4.2
		274	150	49	40.4		3.73	-0.02	3.71	3.7
		355	194	49	35.8		3.00	-0.02	2.98	3.01
		"	"	89	3.2	-0.16	3.04		3.04	
292.	Juli 8	71 20	216							
	6.30 a.m.	22 59 E.	0		7.8				7.8	7.8
		395	216	89	3.95	-0.14	3.81		3.81	3.73
		"	"	I	3.6	+0.08	3.68	-0.04	3.64	

No. 275. Therm. 89 synes at have registreret Bundtemperaturen for høj, B for lavt. Der er taget Middel af begge.
Therm. No. 89 would seem to have registered the Bottom-Temp. too high, Therm. B too low. I have taken the mean.

No. 276. Therm. No. 89 maaske for høj.
Therm. No. 89 perhaps too high.

No. 280. Therm. No. 89 registeret for højt.
Therm. No. 89 too high.

No. 286. Therm. No. 89 registreret for højt.
Therm. No. 89 too high.

No. 287. Therm. No. 89 i ny Trækasse.
Therm. 89 in new case.

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1878	° '			°	°	°		°	°
293.	Juli 13	71 7	95							
	6.0 p.m.	21 11 E.	0		9.7				9.7	9.7
		18	10	I	8.0	+0.05	8.05		8.05	8.1
		37	20	48	78.9		7.20		7.20	7.2
		73	40	46	53.6		6.04	-0.01	6.03	6.0
		110	60	B	208.2		5.50	+0.19	5.69	5.7
		146	80	49	51.0		5.39	-0.01	5.38	5.4
		174	95	89	5.6	-0.10	5.50			5.1
		„	„	48	66.5		5.15	-0.01	5.14	
294.	Juli 14	71 35	637							
	0.0 p.m.	15 11 E.	0		9.1				9.1	9.1
		1165	637	89	-1.0	-0.25	-1.25		-1.25	-1.20
		„	„	I	-1.2	+0.11	-1.09	-0.12	-1.21	
		„	„	48	30.0		-1.00	-0.08	-1.08	
		„	„	B	231.0		-2.24	+0.99	-1.25	
295.	Juli 14	71 59	1110							
	11.30 p.m.	11 40 E.	0		7.0				7.0	7.0
		37	20	48	73.0		6.22		6.22	6.2
		91	50	46	39.7		3.95	-0.01	3.94	3.9
		183	100	49	37.2		3.22	-0.01	3.21	3.2
		366	200	I	2.5	+0.09	2.59	-0.04	2.55	2.6
		549	300	49	29.4		2.00	-0.03	1.97	2.0
		732	400	46	22.9		1.35	-0.10	1.25	1.3
		914	500	48	36.0		0.00	-0.06	-0.06	-0.1
		1097	600	B	229.5		-1.70	+0.94	-0.76	-0.8
		„	„	89	-0.6	-0.25	-0.85		-0.85	
		2030	1110	89	-1.1	-0.26	-1.36		-1.36	-1.30
		„	„	48	29.5		-1.10	-0.14	-1.24	
296.	Juli 15	72 15	1440							
	7.0 p.m.	8 9 E.	0		6.7				6.7	6.3
		0	„		6.1				6.1	
		37	20	I	5.0	+0.07	5.07		5.07	5.1
		91	50	49	39.8		3.64	-0.01	3.63	3.6
		183	100	48	54.2		3.11	-0.01	3.10	3.1
		366	200	I	2.5	+0.09	2.59	-0.04	2.55	2.6
		549	300	46	28.0		2.12	-0.07	2.05	2.1
		732	400	49	24.9		1.26	-0.04	1.22	1.2
		914	500	B	226.9		-0.85	+0.79	-0.06	-0.1
		1097	600	48	33.1		-0.46	-0.08	-0.54	-0.5
		2633	1440	89	-1.1	-0.21	-1.31	0.00	-1.31	-1.35
		„	„	I	-1.2	+0.11	-1.09	-0.27	-1.36	
		„	„	49	9.2		-1.23	-0.15	-1.38	
297.	Juli 16	72 36	1280							
	9.0 a.m.	5 12 E.	0		4.8				4.8	4.6
			„		4.4				4.4	
		18	10	I	4.1	+0.08	4.18		4.18	4.2
		37	20	I	0.5	+0.10	0.60		0.60	0.6
		55	30	48	35.0		-0.17		-0.17	-0.2
		91	50	49	11.9		-0.82	-0.01	-0.83	-0.8
		128	70	B	227.0		-0.89	+0.11	-0.78	-0.8
		165	90	46	12.5		-0.25	-0.02	-0.27	-0.3
		183	100	I	-0.3	+0.11	-0.19	-0.02	-0.21	-0.2
		366	200	48	35.0		-0.17	-0.03	-0.20	-0.2
		549	300	B	227.0		-0.89	+0.46	-0.43	-0.4
		732	400	49	12.5		-0.70	-0.04	-0.74	-0.7
		914	500	46	8.1		-0.96	-0.12	-1.08	-1.1
		2341	1280	89	-1.15	-0.26	-1.41		-1.41	-1.37
		„	„	46	7.4		-1.07	-0.31	-1.38	
		„	„	II	-1.15	+0.06	-1.09	-0.23	-1.32	
298.	Juli 17	72 52	1500							
	4.0 a.m.	1 51 E.	0		4.0				4.0	4.0
		18	10	91	4.0	-0.13	3.87		3.87	3.9
		37	20	„	2.4	-0.15	2.25		2.25	2.3
		55	30	„	0.1	-0.16	-0.06		-0.06	-0.1
		73	40	„	-0.65	-0.17	-0.82		-0.82	-0.8
		91	50	„	-1.0	-0.17	-1.17		-1 17	-1.2
		110	60	„	-0.9	-0.17	-1.07		-1.07	-1.1
		146	80	„	-0.2	-0.16	-0.36		-0.36	-0.4
		183	100	„	0.15	-0.16	-0.01		-0.01	0.0
298. f.		219	120	91	0.2	-0.16	0.04		0.04	0.0
		274	150	„	0.0	-0.16	-0.16		-0.16	-0.2
		366	200	„	-0.35	-0.17	-0.52		-0.52	-0.5
		732	400	„	-0.8	-0.17	-0.97		-0.97	-1.0
		2743	1500	89	-1.2	-0.26	-1.46		-1.46	-1.49
		„	„	III	-1.6	+0.18	-1.42	-0.14	-1.56	
		„	„	B	235.6		-3.78	+2.34	-1.44	
299.	Juli 17	73 10	1366							
	5.30 p.m.	2 14 W.	0		3.6				3.6	3.6
		2498	1366	89	-1.35	-0.26	-1.61		-1.61	-1.60
		„	„	IV	-1.5	+0.01	-1.49	-0.10	-1.59	
300.	Juli 17	73 10								
	10.0 p.m.	3 22 W.	0		1.7				1.7	1.7
		18	10	I	-0.2	+0.11	-0.09		-0.09	-0.1
		37	20	48	32.0		-0.67		-0.67	-0.7
		55	30	46	8.2		-0.95	-0.01	-0.96	-1.0
		73	40	49	7.0		-1.59	0.00	-1.59	-1.6
		91	50	B	229.0		-1.57	+0.07	-1.50	-1.5
		183	100	89	0.0	-0.23	-0.23		-0.23	-0.2
301.	Juli 18	74 1	1684							
	11.0 a.m.	1 20 W.	0		2.2				2.2	2.2
		3080	1684	89	-1.25	-0.26	-1.51		-1.51	-1.56
		„	„	48	28.0		-1.37	-0.21	-1.58	
		„	„	VI	-1.5	+0.09	-1.41	-0.19	-1.60	
302.	Juli 19	75 16	1985							
	7.0 a.m.	0 54 W.	0		3.0				3.0	3.0
		18	10	VII	2.9	+0.11	3.01		3.01	3.0
		37	20	B	224.5		0.00	+0.03	0.03	0.0
		55	30	46	8.0		-0.99	-0.01	-1.00	-1.0
		73	40	48	29.5		-1.10	0.00	-1.10	-1.1
		91	50	B	227.7		-1.10	+0.08	-1.02	-1.0
		183	100	89	-1.0	-0.25	-1.25		-1.25	-1.3
		366	200	89	-1.1	-0.26	-1.36		-1.36	-1.4
		3630	1985	89	-1.22	-0.26	-1.48		-1.48	-1.70
		„	„	49	13.7		-0.50	-0.21	-0.71	
		„	„	VII	-1.9	+0.16	-1.74	-0.21	-1.95	
303.	Juli 19	75 12	1200							
	7.0 p.m.	3 2 E.	0		3.3				3.3	3.3
		0	„		3.1				3.1	3.1
		18	10	IX	3.0	-0.08	2.92		2.92	2.9
		37	20	I	1.0	+0.10	1.10		1.10	1.1
		55	30	B	226.0		-0.52	+0.05	-0.47	-0.5
		73	40	48	30.0		-1.00	0.00	-1.00	-1.0
		91	50	46	7.6		-1.05	-0.01	-1.04	-1.0
		183	100	89	-0.8	-0.25	-1.05		-1.05	-1.1
		914	500	89	-1.1	-0.26	-1.36		-1.36	-1.26
		„	„	B	230.1		-1.93	+0.78	-1.15	
		2195	1200	89	-1.35	-0.26	-1.61		-1.61	-1.57
		„	„	B	234.5		-3.40	+1.89	-1.51	
		„	„	I	-1.5	+0.12	-1.38	-0.22	-1.60	
304.	Juli 20	75 3	1735							
	0.30 p.m.	4 51 E.	0		3.6				3.6	3.6
		18	10	II	1.7	+0.11	1.81		1.81	1.8
		37	20	I	-1.0	+0.11	-0.89		-0.89	-0.9
		55	30	B	227.1		-0.93	+0.05	-0.88	-0.9
		73	40	48	33.6		-0.40	0.00	-0.40	-0.4
		91	50	46	11.0		-0.50	-0.01	-0.51	-0.5
		183	100	89	-0.05	-0.24	-0.29		-0.29	-0.3
		366	200	46	11.0		-0.50	-0.05	-0.55	-0.6
		549	300	48	31.7		-0.72	-0.04	-0.76	-0.8
		2624	1435	46	6.5		-1.22	-0.35	-1.57	-1.5
		3173	1735	89	-1.2	-0.26	-1.46		-1.46	-1.50
		„	„	48	24.3		-1.98	-0.22	-2.20	
		„	„	II	-1.3	+0.06	-1.24	-0.31	-1.55	

No. 293. Therm. No. 89 registreret Bundtemperaturen for høj.
Therm No. 89 has registered the Bottom-Temp. too high.

No. 294. Taget til Verification af No. 201.
Sounding taken to verify No. 201.

No. 295. Temperaturrækken taget Juli 15, 8—10 a.m. 71° 55′ N., 11′ 30′ E.
The Serial Temp. taken 15 July, 8—10 a.m. in Lat. 71° 55′ N., Long. 11° 30′ E.

No. 300. Kun Temperaturrække. Therm. No. 89 maaske for højt i 100 Fv.
Only Serial Temperatures. Therm. No. 89 perhaps too high in 100 fms.

No. 302. Therm. No. 49 har ikke registreret rigtig, hverken ved Bunden eller i 50 Favne. Disse Obs. ere casserede.
Therm. No. 49 has not registered correctly, either at the bottom or in 50 fms. These observations were rejected.

No. 304. Therm. No. 48 har registreret for lavt ved Bunden. No. 46 synes at have registreret lidt for lavt i 50 og 1435 Fv.
Therm. No. 48 has registered too low at the bottom. No. 46 would seem to have registered a little too low in 50 and 1435 fms

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1878	° '			°	°	°	°	°	°
305.	Juli 20	75 1	1590							
	11.30 p.m.	7 56 E.	0		5.3				5.3	5.3
		18	10	II	4.9	+0.16	5.06		5.06	5.1
		37	20	I	3.55	+0.08	3.63		3.63	3.6
		55	30	48	50.1		2.41		2.41	
		73	40	46	31.0		2.60	0	2.60	2.6
		91	50	B	220.8		1.22	+0.08	1.30	1.3
		128	70	B	221.0		1.18	+0.11	1.29	1.3
		183	100	46	20.2		0.94	-0.02	0.92	0.9
		274	150	48	43.0		1.21	-0.02	1.19	
		366	200	IV	0.5	+0.06	0.56	-0.02	0.54	0.5
		457	250	III	0.25	+0.08	0.33	-0.04	0.29	0.3
		549	300	I	0.2	+0.10	0.30	-0.05	0.25	0.3
		640	350	46	14.5		0.04	-0.09	-0.05	-0.1
		732	400	B	227.2		-0.95	+0.61	-0.34	-0.3
		2908	1590	89	-1.1	-0.26	-1.36		-1.36	-1.48
		"	"	46	7.0		-1.15	-0.39	-1.54	
		"	"	III	-1.55	+0.18	-1.37	-0.16	-1.53	
306.	Juli 21	75 0	1334							
	8.23 a.m.	10 27 E.	0		5.4				5.4	5.4
		37	20	I	3.4	+0.08	3.48		3.48	3.5
		91	50	II	2.6	+0.12	2.72	-0.01	2.71	2.7
		183	100	IV	2.1	+0.10	2.20	-0.01	2.19	2.2
		366	200	IX	1.7	-0.11	1.59	-0.03	1.56	1.6
		549	300	I	1.05	+0.10	1.15	-0.05	1.10	1.1
		732	400	III	0.5	+0.21	0.71	-0.04	0.67	0.7
		914	500	89	0.0	-0.23	-0.23		-0.23	-0.2
		2440	1334	89	-1.05	-0.26	-1.31		-1.31	-1.34
		"	"	B	234.7		-3.46	+2.08	-1.38	
		"	"	IV	-1.25	+0.02	-1.23	-0.10	-1.33	
307.	Juli 21	74 58	1216							
	3.15 p.m.	12 10 E.	0		5.8				5.8	5.8
		1858	1016	II	-1.0	+0.07	-0.93	-0.18	-1.13	-1.1
		2224	1216	89	-1.1	-0.26	-1.36		-1.36	-1.35
		"	"	48	29.0		-1.19	-0.16	-1.35	
		"	"	IX	-1.0	-0.17	-1.17	-0.16	-1.33	
308.	Juli 21	74 57	1136							
	6.0 p.m.	12 43 E.	0		5.3				5.3	5.3
		0	"		5.2					
		183	100	III	2.5	+0.24	2.74	-0.01	2.73	2.7
		366	200	II	1.7	+0.11	1.81	-0.03	1.78	1.8
		549	300	I	1.1	+0.10	1.20	-0.06	1.14	1.1
		732	400	IV	1.0	+0.08	1.08	-0.03	1.05	1.1
		914	500	B	225.1		-0.23	+0.78	0.55	0.6
		1097	600	89	-0.1	-0.23	-0.33		-0.33	-0.3
		1529	836	IV	-1.0	+0.02	-0.98	-0.06	-1.04	-1.0
		2078	1136	89	-1.1	-0.26	-1.36		-1.36	-1.33
		"	"	46	7.2		-1.10	-0.28	-1.38	
		"	"	VI	-1.2	+0.09	-1.11	-0.13	-1.24	
309.	Juli 21	74 57	1065							
	9.30 p.m.	13 18 E.	0		5.6				5.6	5.6
		1948	1065	89	-1.05	-0.26	-1.31		-1.31	-1.29
		"	"	49	9.5		-1.18	-0.11	-1.29	
		"	"	VII	-1.3	+0.15	-1.15	-0.11	-1.26	
310.	Juli 21	74 56	1006							
	11.50 p.m.	13 50 E.	0		5.5				5.5	5.5
		1840	1006	89	-1.1	-0.26	-1.36		-1.36	-1.39
		"	"	B	233.1		-2.97	+1.57	-1.40	
		"	"	IX	-1.1	-0.17	-1.27	-0.13	-1.40	
311.	Juli 22	74 55	898							
	2.40 a.m.	14 25 E.	0		5.8				5.8	5.8
		1642	898	89	-1.05	-0.26	-1.31		-1.31	-1.29
		"	"	48	29.0		-1.19	-0.11	-1.30	
		"	"	I	-1.2	+0.11	-1.09	-0.16	-1.25	
312.	Juli 22	74 54	658							
	5.30 a.m.	14 53 E.	0		6.0				6.0	6.0
		1203	658	89	-1.1	-0.26	-1.36		-1.36	-1.23
		"	"	49	9.5		-1.18	-0.07	-1.25	
		"	"	III	-1.2	+0.18	-1.02	-0.06	-1.08	

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1878	° '			°	°	°	°	°	°
313.	Juli 22	74 55	204							
	2.20 p.m.	15 49 E.	0		7.0				7.0	7.0
		373	204	89	2.6	-0.17	2.43	0	2.43	2.44
		"	"	II	2.3	+0.12	2.42	-0.04	2.38	
		"	"	46	30.7		2.57	-0.05	2.52	
314.	Juli 22	74 55	509							
	3.45 p.m.	15 21 E.	0		7.1				7.1	7.1
		37	20	IX	6.2		6.20		6.20	6.2
		91	50	VII	4.9	+0.10	5.00		5.00	5.0
		183	100	III	3.75	+0.26	4.01	-0.01	4.00	4.0
		366	200	II	2.55	+0.12	2.67	-0.04	2.63	2.6
		549	300	I	2.0	+0.09	2.09	-0.05	2.04	2.0
		732	400	B	223.8		0.23	+0.61	0.84	0.8
		931	509	89	-0.3	-0.23	-0.53		-0.53	-0.56
		"	"	B	228.5		-1.35	+0.80	-0.55	
		"	"	III	-0.75	+0.19	-0.56	-0.05	-0.61	
315.	Juli 22	74 53	180							
	6.40 p.m.	15 55 E.	0		6.7				6.7	6.7
		329	180	89	2.6	-0.17	2.43		2.43	2.50
		"	"	III	2.35	+0.24	2.59	-0.02	2.57	
316.	Juli 22	74 56	129							
	11.0 p.m.	16 29 E.	0		3.6				3.6	3.6
		236	129	89	2.1	-0.18	1.92		1.92	1.92
		"	"	III	1.7	+0.23	1.93	-0.01	1.92	
317.	Juli 23	74 56	99							
	0.16 a.m.	16 52 E.	0		3.4				3.4	3.4
		181	99	89	2.6	-0.17	2.43		2.43	2.26
		"	"	I	2.0	+0.09	2.09		2.09	
318.	Juli 23	74 56	55							
	2.32 a.m.	17 39 E.	0		3.2				3.2	3.2
		101	55	III	1.85	+0.23	2.08		2.08	2.1
319.	Juli 23	74 57	45							
	5.0 a.m.	18 22 E.	0		2.6				2.6	2.6
		82	45	III	1.95	+0.23	2.18		2.18	2.2
320.	Juli 23	74 57	31							
	7.0 a.m.	19 8 E.	0		0.8				0.8	0.8
		57	31	II	0.8	+0.10	0.90		0.90	0.9
321.	Juli 23	74 56	25							
	8.30 a.m.	19 30 E.	0		0.5				0.5	0.5
		46	25	I	0.0	+0.10	0.10		0.10	0.18
		"	"	B	223.9		0.23	+0.04	0.27	
322.	Juli 23	74 57	21							
	9.15 a.m.	19 52 W.	0		0.5				0.5	0.5
		38	21	I	0.1	+0.10	0.20		0.20	0.24
		"	"	B	223.8		0.25	+0.03	0.28	
323.	Juli 30	72 53	223							
	3.20 p.m.	21 51 E.	0		7.8				7.8	7.8
	7.0 p.m.	0	"		7.6				7.6	7.6
		37	20	I	6.45	+0.06	6.51		6.51	6.5
		91	50	46	48.0		5.19	-0.01	5.18	5.2
		183	100	49	41.9		3.97	-0.03	3.94	3.9
		274	150	B	217.0		2.55	+0.23	2.78	2.8
		366	200	48	48.0		2.01	-0.03	1.98	2.0
		408	223	89	2.0	-0.18	1.82			1.46
		"	"	B	221.1		1.12	+0.34	1.46	
324.	Juli 31	73 47	233							
	5.0 a.m.	20 48 E.	0		6.9				6.9	6.9
		37	20	I	5.2	+0.07	5.27		5.27	5.3
		91	50	46	15.3		0.18			3.2
		"	"	I	3.1	+0.08	3.18		3.18	
		183	100	B	217.7		2.30	+0.16	2.46	2.5
		274	150	49	29.3		1.97	-0.02	1.95	2.0
		426	233	89	1.1	-0.21	0.89		0.89	0.87
		"	"	I	0.8	+0.10	0.90	-0.04	0.86	

No. 305. Therm. No. 48 synes at have registreret for lavt i 30 Favne og for højt i 150 Favne.
Therm. No. 48 would seem to have registered too low in 30 fms. and too high in 150 fms.

No. 317. Therm. No. 89 maaske for højt.
Therm. No. 89 perhaps too high.

No. 323. Therm. No. 89 synes at have registreret Bundtemp. for højt.
Therm. No. 89 would seem to have registered the Bottom-Temp. too high.

No. 324. Therm. No. 46 for lavt i 50 Fv.
Therm. No. 45 too low in 50 fms.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1878	° ′			°	°	°	°	°	°
325.	Juli 31	74 2	90							
	8.32 a.m.	20 30 E.	0		2.8				2.8	2.8
		91	50	I	0.66	+0.10	0.76		0.76	0.8
		165	90	89	1.1	-0.21	0.89		0.89	0.90
		„	„	I	0.8	+0.10	0.90		0.90	
326.	Aug. 3	75 31	123							
	7.0 p.m.	17 50 E.	0		4.8				4.8	4.8
		37	20	I	2.95	+0.09	3.04		3.04	3.0
		91	50	49	28.0		1.76	-0.01	1.75	1.8
		225	123	89	1.8	-0.19	1.61		1.61	1.57
		„	„	49	26.6		1.54	-0.01	1.53	
327.	Aug. 4	75 39	188							
	1.15 a.m.	16 33 E.	0		4.7				4.7	4.7
		344	188	89	1.3	-0.20	1.10		1.10	0.7
		„	„	I	0.6	+0.10	0.70	-0.04	0.66	
328.	Aug. 4	75 42	200							
	4.10 a.m.	15 39 E.	0		4.7				4.7	4.7
		366	200	89	-0.2	-0.23	-0.43			1.26
		„	„	B	229.5		-1.70	+0.31	-1.39	
		„	„	I	-1.2	+0.10	-1.10	-0.04	-1.14	
329.	Aug. 4	75 45	199							
	7.0 a.m.	14 45 E.	0		5.0				5.0	5.0
		364	199	89	-0.2	-0 23	-0.43		-0.43	-0.6
		„	„	49	13.1		-0.58	-0.03	-0.61	
330.	Aug. 4	75 48	444							
	9.30 a.m.	13 54 E.	0		6.7				6.7	6.7
		37	20	I	6.6	+0.06	6.66		6.66	6.7
		91	50	48	67.0		5.23	-0.01	5.22	5.2
		183	100	48	61.7		4.35	-0.01	4.34	4.3
		366	200	46	30.0		2.43	-0.05	2.38	2.4
		549	300	49	26.3		1.50	-0.03	1.47	1.5
		732	400	B	222.1		0.80	+0.61	1.41	1.4
		812	444	89	1.3	-0.20	1.10		1.10	0.4
		„	„	46	17.2		0.50	-0.11	0.39	
331.	Aug. 4	75 51	795							
	0.30 p.m.	13 5 E.	0		6.8				6.8	6.8
		183	100	89	3.9	-0.14	3.76		3.76	3.7
		„	„	91	3.8	-0.13	3.67		3.67	
		732	400	89	1.0	-0.21	0.79		0.79	0.8
		1088	595	B	230.0		-1.90	+0.92	-0.98	-1.0
		1454	795	91	-1.1	-0.17	-1.27		-1.27	-1.28
		„	„	48	29.0		-1.20	-0.10	-1.30	
332.	Aug. 4	75 56	1149							
	6.0 p.m.	11 36 E.	0		5.8				5.8	5.8
		18	10	I	5.7	+0.06	5.76		5.76	5.8
		2101	1149	89	-1.15	-0.26	-1.41		-1.41	-1.48
		„	„	B	234.0		-3.24	+1.80	-1.44	
		„	„	I	-1.5	+0.12	-1.38	-0.21	-1.59	
333.	Aug. 4	76 6	748							
	11.0 p.m.	13 10 E.	0		5.8				5.8	5.8
		1368	748	89	-1.1	-0.26	-1.36		-1.36	-1.32
		„	„	49	9.5		-1.19	-0.08	-1.27	
334.	Aug. 5	76 12	403							
	9.0 a.m.	14 0 E.	0		6.0				6.0	6.0
		737	403	91	1.1	-0.16	0.94		0.94	0.95
		„	„	49	23.1		1.00	-0.04	0.96	
335.	Aug. 5	76 16	179							
	11.0 a.m.	14 39 E.	0		5.4				5.4	5.4
		37	20	I	5.5	+0.07	5.57		5.57	5.6
		73	40	48	67.3		5.27		5.27	5.3
		110	60	46	45.2		4.80	-0.01	4.79	4.8
		146	80	49	45.9		4.58	-0.01	4.57	4.6
		183	100	B	213.0		3.90	+0.16	4.06	4.1
		274	150	91	2.9	-0.14	2.76		2.76	2.8
	1878	° ′			°	°	°	°	°	°
335. f.		327	179	91	1.75	-0.15	1.60		1.60	1.0
		„	„	I	0.9	+0.10	1.00	-0.03	0.97	
336.	Aug. 5	76 19	70							
	2.10 p.m.	15 42 E.	0		1.2				1.2	1.2
		128	70	89	0.7	-0.21	0.49		0.49	0.44
		„	„	48	38.5		0.44	-0.01	0.43	
		„	„	I	0.3	+0.10	0.40	-0.01	0.39	
337.	Aug. 5	76 23	20							
	6.12 p.m.	16 43 E.	0		2.8				2.8	2.8
		37	20	I	1.3	+0.10	1.40		1.40	1.4
338.	Aug. 6	76 16	146							
	10.0 a.m.	17 49 E.	0		3.6				3.6	3.7
		0	„		3.7				3.7	
		37	20	I	1.65	+0.09	1.74		1.74	1.7
		73	40	48	52.0		2.72		2.72	2.7
		110	60	B	218.8		1.91	+0.09	2.00	2.0
		146	80	46	31.0		2.60	-0.02	2.58	2.6
		183	100	49	30.0		2.10	-0.01	2.09	2.1
		219	120	B	225.2		-0.25	+0.19	-0.06	-0.1
		„	„	91	0.5	-0.16	0.34			
		238	130	91	-0.5	-0.17	-0.67			-1.0
		„	„	89	-0 4	-0.24	-0.64			
		„	„	I	-1.0	+0.11	-0.89	-0.02	-0.91	
		„	„	B	228.0		-1.22	+0.20	-1.00	
		267	146	91	-0.3	-0.17	-0.47			-1.06
		„	„	B	228.3		-1.31	+0.21	-1.10	
		„	„	I	-1.1	+0.11	-0.99	-0.03	-1.02	
339.	Aug. 6	76 30	37							
	5.0 p.m.	15 39 E.	0		2.6				2.6	2.6
		68	37	89	1.05	-0.21	0.84		0.84	0.87
		„	„	I	0.8	+0.10	0.90		0.90	
340.	Aug. 6	76 31	58							
	7.30 p.m.	14 40 E.	0		2.8				2.8	2.8
		106	58	89	2.3	-0.18	2.12			0.6
		„	„	B	223.0		0.50	+0.09	0.59	
341.	Aug. 6	76 32	118							
	9.20 p.m.	13 53 E.	0		4.0				4.0	4.0
		216	118	89	2.6	-0.17	2.43			0.75
		„	„	49	21.6		0.75	-0.03	0.72	
		„	„	I	0.7	+0.10	0.80	-0.02	0.78	
342.	Aug. 6	76 33	523							
	11.0 p.m.	13 18 E.	0		6.2				6.2	6.2
		37	20	46	53.2		6.00		6.00	6.0
		91	50	49	45.5		4.52	-0.01	4.51	4.5
		183	100	I	3.8	+0.08	3.88	-0.02	3.86	3.9
		366	200	46	31.5		2.67	-0.05	2.62	2.6
		549	300	B	220.1		1.46	+0.46	1.91	1.9
		732	400	49	23.5		1.05	-0.04	1.01	1.0
		914	500	89	-0.4	-0.24	-0.64		-0.64	-0.6
		956	523	89	-0.8	-0.25	-1.05		-1.05	-1.02
		„	„	49	12.7		-0.69	-0.06	-0.75	
		„	„	I	-1.0	+0.11	-0.89	-0.10	-0.99	
343.	Aug. 7	76 34	743							
	1.30 a.m.	12 51 E.	0		5.8				5.8	5.8
		1359	743	89	-1.0	-0.25	-1.25		-1.25	-1.19
		„	„	I	-1.1	+0.11	-0.99	-0.13	-1.12	
344.	Aug. 7	76 42	1017							
	1.0 p.m.	11 16 E.	0		5.2				5.2	5.2
		1860	1017	89	-1.0	-0.25	-1.25		-1.25	-1.28
		„	„	46	7.6		-1.05	-0.25	-1.30	
		„	„	I	-1.2	+0.11	-1.09	-0.19	-1.28	

No. 327. Therm. No. 89 registreret for høj Bundtemperatur.
Therm. No. 89 has registered too high a Bottom-Temperature.

No. 328. Therm. No. 89 registreret for høj Bundtemperatur.
Therm. No. 89 has registered too high a Bottom-Temp.

No. 329. Therm. No. 89 synes at have registreret lidt for højt.
Therm. No. 89 would seem to have registered a little too high.

No. 330. Therm. No. 89 for høj Bundtemp.
Therm. No. 89 too high Bottom-Temp.

No. 335. Therm. No. 91 registreret for høj Bundtemperatur.
Therm. No. 91 has registered too high a Bottom-Temp.

No. 338. Vendethermometrene No. 89 og 91 have registreret for højt.
The Inverting-Therms. Nos. 89 and 91 have registered too high.

No. 340. Therm. No. 89 har registreret for højt.
Therm. No. 89 has registered too high.

No. 341. Therm. No. 89 har registreret for højt.
Therm. No. 89 has registered too high.

No. 342. Therm. No. 49 synes at have registreret Bundtemperaturen noget for lavt.
Therm. No. 49 would seem to have registered the Bottom-Temp. a trifle too low.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1878	° ′								
345.	Aug. 7	76 42			°				°	°
	3.45 p.m.	10 9 E.	0		5.1	°	°		5.1	5.1
		37	20	I	2.7	+0.09	2.79		2.79	2.8
		91	50	48	47.3		1.95	°	1.95	2.0
		183	100	I	1.5	+0.09	1.59	-0.02	1.57	1.6
		366	200	48	43.4		1.26	-0.02	1.24	1.2
		549	300	49	23.1		1.03	-0.03	1.00	1.0
		732	400	B	224.6		-0.05	+0.61	0.56	0.6
		914	500	46	12.6		-0.25	-0.12	-0.37	-0.4
346.	Aug. 7	76 41								
	7.30 p.m.	9 4 E.	0		5.0				5.0	5.0
		37	20	I	2.7	+0.09	2.79		2.79	2.8
		91	50	46	30.9		2.59	-0.01	2.58	2.6
		183	100	89	2.05	-0.18	1.87		1.87	1.9
347.	Aug. 7	76 40	1429							
	11.0 p.m.	7 47 E.	0		4.4				4.4	4.4
		183	100	I	1.5	+0.10	1.60	-0.02	1.58	1.6
		366	200	46	22.6		1.31	-0.05	1.26	1.3
		549	300	B	223.1		0.45	+0.47	0.92	0.9
		732	400	49	21.6		0.75	-0.04	0.71	0.7
		914	500	89	0.05	-0.23	-0.28		-0.28	-0.17
		”	”	48	36.0		0.00	-0.06	-0.06	
		2613	1429	89	-1.0	-0.25	-1.25		-1.25	-1.30
		”	”	48	29.1		-1.15	-0.19	-1.34	
		”	”	VII	-1.3	+0.15	-1.15	-0.15	-1.30	
348.	Aug. 8	76 34								
	8.40 a.m.	4 52 E.	0		4.1				4.1	4.1
		18	10	I	4.0	+0.08	4.08		4.08	4.1
		37	20	48	43.2		1.22		1.22	1.2
		73	40	49	8.8		-1.32		-1.32	-1.3
		110	60	B	228.4		-1.33	+0.09	-1.24	-1.2
		146	80	46	10.2		-0.62	-0.02	-0.64	-0.6
		183	100	I	-0.7	+0.11	-0.59	-0.02	-0.61	-0.6
		”	”	89	0.2	-0.23	-0.03			
249.	Aug. 8	76 30	1487							
	0.30 p.m.	2 57 E.	0		3.8				3.8	3.8
		2719	1487	89	-1.2	-0.26	-1.46		-1.46	-1.53
		”	”	49	7.9		-1.45	-0.16	-1.61	
		”	”	II	-1.3	+0.06	-1.24	-0.27	-1.51	
350.	Aug. 8	76 26	1686							
	9.25 p.m.	0 29 W.	0		3.2				3.0	3.0
		18	10	I	3.0	+0.09	3.09		3.09	3.1
		37	20	48	32.0		-0.68		-0.68	-0.7
		73	40	B	228.7		-1.45	+0.06	-1.39	-1.4
		110	60	46	8.3		-0.92		-0.92	-0.9
		146	80	91	-0.2	-0.16	-0.36		-0.36	-0.4
		183	100	91	-0.4	-0.17	-0.57		-0.57	-0.6
		366	200	89	-0.5	-0.24	-0.74		-0.74	-0.7
		549	300	I	-1.15	+0.11	-1.04	-0.05	-1.09	-1.1
		2533	1385	I	-1.4	+0.11	-1.29	-0.25	-1.54	-1.5
		3083	1686	89	-1.3	-0.26	-1.56		-1.56	-1.53
		”	”	B	236.5		-4.05	+2.62	-1.43	
		”	”	VI	-1.5	+0.09	-1.41	-0.19	-1.60	
351.	Aug. 10	77 49	1640							
	4.0 a.m.	0 9 W.	0		3.3				3.3	3.3
		18	10	I	2.3	+0.09	2.39		2.39	2.4
		37	20	VI	-0.1	+0.12	0.02		0.02	0.0
		73	40	IV	-0.2	+0.04	-0.16		-0.16	-0.2
		110	60	48	37.0		0.19	-0.01	0.18	0.2
		146	80	46	15.6		0.22	-0.02	0.20	0.2
		183	100	91	0.3	-0.16	0.14		0.14	0.1
		366	200	89	0.1	-0.22	-0.12		-0.12	-0.1
		2999	1640	89	-1.2	-0.26	-1.46		-1.46	-1.51
		”	”	48	28.0		-1.37	-0.21	-1.58	
		”	”	VI	-1.4	+0.09	-1.31	-0.19	-1.50	
	1878	° ′								
352.	Aug. 10	77 56	1686		°				°	°
	1.0 p.m.	3 29 E.	0		3.9	°	°		3.9	3.9
		18	10	I	2.2	+0.09	2.29	°	2.29	2.3
		37	20	B	223.5		0.34	+0.03	0.37	0.4
		73	40	VI	-0.6	+0.11	-0.49		-0.49	-0.5
		110	60	46	14.0		-0.03	-0.01	-0.04	0.0
		146	80	48	32.2		-0.62	-0.01		-0.1
		183	100	91	0.2	-0.16	0.04		0.04	0.0
		”	”	”	0.45	-0.16	0.29		0.29	
		”	”	III	-0.45	+0.20	-0.25	-0.01	-0.24	
		366	200	46	12.1		-0.31	-0.05	-0.36	-0.4
		”	”	B	226.5		-0.70	+0.31	-0.39	
		549	300	89	-0.65	-0.25	-0.90		-0.90	-0.8
		”	”	48	31.7		-0.73	-0.04	-0.74	
		2535	1386	48	25.8		-1.75	-0.18	-1.93	
		3083	1686	89	-1.2	-0.26	-1.46		-1.46	-1.47
		”	”	46	7.7		-1.05	-0.41	-1.46	
		”	”	III	-1.5	+0.18	-1.32	-0.17	-1.49	
353.	Aug. 10	77 58	1333							
	7.30 p.m.	5 10 E.	0		4.4				4.4	4.3
		0	”		4.2				4.2	
		18	10	VI	2.9	+0.20	3.10		3.10	3.1
		37	20	II	1.2	+0.10	1.30		1.30	1.3
		73	40	I	1.1	+0.10	1.20	-0.01	1.19	1.2
		110	60	46	22.8		1.34	-0.01	1.33	1.3
		146	80	B	221.6		0.97	+0.12	1.09	1.1
		183	100	91	1.1	-0.15	0.95		0.95	1.0
		366	200	II	0.6	+0.09	0.69	-0.03	0.66	0.7
		549	300	B	224.5		0.00	+0.47	0.47	0.5
		732	400	89	0.0	-0.23	-0.23		-0.23	-0.2
		”	”	I	-0.2	+0.11	-0.09	-0.08	-0.17	
		2438	1333	89	-1.2	-0.26	-1.46		-1.46	-1.42
		”	”	46	7.4		-1.08	-0.33	-1.41	
		”	”	II	-1.2	+0.06	-1.14	-0.24	-1.38	
354.	Aug. 11	78 1	1343							
	4.40 p.m.	6 54 E.	0		4.5				4.5	4.5
		37	20	VI	1.7	+0.16	1.86		1.86	1.9
		”	”	91	3.1	-0.14	2.96			
		91	50	III	1.0	+0.22	1.22		1.22	1.2
		183	100	91	0.8	-0.16	0.64		0.64	0.6
		366	200	II	0.5	+0.09	0.59	-0.03	0.56	0.6
		549	300	I	0.0	+0.10	0.10	-0.06	0.04	0.0
		732	400	B	227.6		-1.08	+0.61	-0.47	-0.5
		914	500	89	-0.6	-0.25	-0.85		-0.85	-0.9
		2456	1343	89	-1.0	-0.25	-1.25		-1.25	-1.29
		”	”	48	29.4		-1.10	-0.17	-1.27	
		”	”	I	-1.2	+0.11	-1.09	-0.25	-1.34	
355.	Aug. 11	78 0	948							
	10.0 p.m.	8 32 E.	0		4.9				4.9	4.9
		37	20	II	2.8	+0.13	2.93		2.93	2.9
		91	50	VI	1.8	+0.17	1.97	-0.01	1.96	2.0
		183	100	91	1.85	-0.15	1.70		1.70	1.7
		366	200	III	0.8	+0.22	1.02	-0.02	1.00	1.0
		549	300	I	0.9	+0.10	1.00	-0.06	0.94	0.9
		732	400	89	0.8	-0.21	0.59		0.59	0.6
		914	500	89	0.15	-0.23	-0.08		-0.08	-0.1
		1097	600	I	-0.7	+0.11	-0.59	-0.11	-0.70	-0.7
		1734	948	89	-1.05	-0.26	-1.31		-1.31	-1.33
		”	”	I	-1.3	+0.11	-1.19	-0.17	-1.36	
356.	Aug. 12	78 2	110							
	3.45 a.m.	10 19 E.	0		4.4				4.4	4.4
		37	20	46	26.6		1.95		1.95	2.0
		73	40	I	1.2	+0.10	1.30	-0.01	1.29	1.3
		110	60	III	1.6	+0.23	1.83	-0.01	1.82	1.8
		146	80	II	1.65	+0.11	1.76	-0.01	1.75	1.8
		165	90	B	220.9		1.20		1.20	1.2
		183	100	VI	1.7	+0.17	1.87	-0.01	1.86	1.9
		201	110	89	2.6	-0.17	2.43			2.1
		”	”	VI	1.9	+0.17	2.07	-0.01	2.06	

No. 345. Kun Temperaturrække.
Only Serial Temperatures.

No. 346. Kun Temperaturrække.
Only Serial Temperatures.

No. 348. Therm. No. 89 registreret for højt i 100 Fv. Kun Temperaturrække.
Therm. No. 89 has registered too high in 100 fms. Only Serial Temps.

No. 352. Therm. No. 48 synes at have registreret c. 0.°5 for lavt i 80 og i 1386 Favne.
Therm. No. 48 would seem to have registered about 0.°5 too low in 80 fms. and 1386 fms.

No. 354. Therm. No. 91 synes at have registreret for højt i 20 Fv.
Therm. No. 91 would seem to have registered too high in 20 fms.

No. 356. Therm. No. 89 synes at have registreret for højt ved Bunden.
Therm. No. 89 would seem to have registered too high at the bottom.

No.	D	φ λ m	h	Th.	t′	c_s	t_s	c_p	t_r	t
	1878	° ′			°	°	°	°	°	°
357.	Aug. 12	78 3	125							
	6.33 a.m.	11 18 E.	0		5.0				5.0	5.0
		37	20	VI	1.0	+0.15	1.15		1.15	1.2
		73	40	II	1.25	+0.10	1.35		1.35	1.4
		110	60	III	0.8	+0.22	1.02	-0.01	1.01	1.0
		146	80	I	1.3	+0.10	1.40	-0.01	1.39	1.4
		165	90	B	221.2		1.10	+0.14	1.24	1.2
		183	100	46	23.7		1.50	-0.02	1.48	1.5
		229	125	91	2.0	-0.15	1.85		1.85	1.9
		„	„	I	1.4	+0.10	1.50	-0.02		
358.	Aug. 12	78 2	93							
	1.45 p.m.	9 46 E.	0		4.3				4.3	4.3
		170	93	89	3.0	-0.16	2.84		2.84	2.63
		„	„	B	217.6		2.35	+0.15	2.50	
		„	„	I	2.5	+0.09	2.59	-0.02	2.57	
359.	Aug. 12	78 2	416							
	3.30 p.m.	9 25 E.	0		4.3				4.3	4.3
		761	416	89	1.0	-0.21	0.79		0.79	0.77
		„	„	B	224.1		0.10	+0.65	0.75	
		„	„	I	0.75	+0.10	0.85	-0.08	0.77	
360.	Aug. 13	78 47	421							
	10.15 a.m.	6 58 E.	0		4.8				4.8	4.8
		770	421	89	0.2	-0.23	-0.03		-0.03	0.0
		„	„	I	0.0	+0.10	0.10	-0.08	0.02	
361.	Aug. 13	79 8	905							
	7.20 p.m.	5 28 E.	0		4.2				4.2	4.2
		37	20	VI	3.0	+0.20	3.20		3.20	3.2
		91	50	II	2.4	+0.12	2.52	-0.01	2.51	2.5
		183	100	91	2.1	-0.15	1.95		1.95	2.0
		366	200	VI	1.95	+0.17	2.12	-0.02	2.00	2.0
		549	300	II	0.66	+0.09	0.75	-0.05	0.70	0.7
		732	400	III	-0.25	+0.20	-0.05	-0.04	-0.09	-0.1
		914	500	I	-0.6	+0.11	-0.49	-0.09	-0.58	-0.6
		1655	905	89	-0.25	-0.23	-0.48		-0.48	-1.2
		„	„	I	-1.1	+0.11	-0.99	-0.17	-1.16	
362.	Aug. 14	79 59	459							
	8.40 a.m.	5 40 E.	0		5.2				5.2	5.2
		37	20	II	4.4	+0.15	4.55		4.55	4.6
		73	40	I	4.0	+0.08	4.08	-0.01	4.07	4.1
		110	60	III	2.8	+0.25	3.05	-0.01	3.04	3.0
		146	80	VI	2.4	+0.18	2.58	-0.01	2.57	2.6
		183	100	III	2.4	+0.24	2.64	-0.01	2.63	2.6
		274	150	I	2.1	+0.09	2.19	-0.03	2.16	2.2
		366	200	II	1.5	+0.11	1.61	-0.03	1.58	1.6
		549	300	VI	0.8	+0.14	0.94	-0.03	0.91	0.9
		732	400	89	0.1	-0.23	-0.13		-0.13	-0.1
		„	„	VI	-0.1	+0.12	-0.02	-0.05	-0.07	
		839	459	89	-0.8	-0.25	-1.05		-1.05	-1.00
		„	„	III	-1.05	+0.18	-0.87	-0.05	-0.92	
		„	„	VI	-1.05	+0.09	-0.96	-0.05	-1.01	
363.	Aug. 14	80 3	260							
	8.20 p.m.	8 28 E.	0		4.6				4.6	4.6
		37	20	VI	4.1	+0.22	4.32		4.32	4.3
		91	50	II	3.3	+0.13	3.43	-0.01	3.42	3.4
		183	100	I	2.9	+0.09	2.99	-0.02	2.97	3.0
		274	150	III	2.2	+0.24	2.44	-0.01	2.43	2.4
		366	200	B	219.6		1.68	+0.31	1.99	2.0
		475	260	89	1.4	-0.20	1.20		1.20	1.14
		„	„	B	222.5		0.67	+0.40	1.07	
		„	„	I	1.0	+0.10	1.10	-0.05	1.15	
364.	Aug. 16	79 48	195							
	6.40 p.m.	10 50 E.	0		3.0				3.0	3.0
		37	20	III	3.0	+0.25	3.25		3.25	3.3
		91	50	I	3.2	+0.19	3.39	-0.01	3.38	3.4
		183	100	II	2.4	+0.12	2.52	-0.02	2.50	2.5
		274	150	VI	2.1	+0.17	2.27	-0.02	2.25	2.3
		357	195	91	2.4	-0.14	2.26		2.26	2.30
		„	„	I	2.3	+0.09	2.39	-0.04	2.35	
365.	Aug. 17	79 34	74							
	8.40 p.m.	11 25 E.	0		2.9				2.9	2.9
		135	74	91	-1.6	-0.17	-1.77		-1.77	-1.8
366.	Aug. 17	79 35	61							
	10.0 p.m.	11 17 E.	0		3.7				3.7	3.7
		112	61	91	-1.9	-0.18	-2.08		-2.08	-2.1
	11.30 p.m.	68	37	91	0.0	-0.16	-0.16		-0.16	-0.2
367.	Aug. 18	78 44	535							
	9.15 a.m.	7 46 E.	0		4.3				4.3	4.3
		978	535	89	-0.5	-0.24	-0.74		-0.74	-0.73
		„	„	46	10.5		-0.57	-0.13	-0.70	
		„	„	I	-0.75	+0.11	-0.64	-0.10	-0.74	
368.	Aug. 18	78 43	315							
	11.15 a.m.	8 20 E.	0		4.6				4.6	4.6
		576	315	89	1.8	-0.19	1.61		1.61	1.65
		„	„	46	24.9		1.68	-0.08	1.60	
		„	„	I	1.7	+0.09	1.79	-0.06	1.73	
369.	Aug. 18	78 42	87							
	0.35 p.m.	8 53 E.	0		4.2				4.2	4.2
		159	87	89	1.5	-0.20	1.30		1.30	0.8
		„	„	I	0.7	+0.10	0.80	-0.02	0.78	
370.	Aug. 18	78 48	109							
	1.20 p.m.	8 37 E.	0		4.4				4.4	4.4
		37	20	II	0.2	+0.08	0.28		0.28	0.2
		„	„	91	0.3	-0.16	0.14		0.14	
		91	50	VI	0.4	+0.27	0.67	-0.01		1.8
		„	„	91	2.0	-0.15	1.85		1.85	
		199	109	89	1.5	-0.20	1.30			1.1
		„	„	I	0.9	+0.10	1.00	-0.02	1.08	
371.	Aug. 19	78 8	197							
	7.30 a.m.	13 46 E.	0		4.1				4.1	4.1
		360	197	89	1.4	-0.20	1.20			-0.5
		„	„	I	-0.6	+0.11	-0.49	-0.04	-0.53	
372.	Aug. 19	78 9	129							
	9.0 a.m.	14 7 E.	0		4.1				4.1	4.1
		236	129	89	1.7	-0.19	1.51		1.51	1.2
		„	„	I	1.1	+0.10	1.20	-0.02	1.18	
373.	Aug. 19	78 10	120							
	11.0 a.m.	14 21 E.	0		4.0				4.0	4.0
		18	10	91	3.2	-0.14	3.06		3.06	3.1
		37	20	„	1.6	-0.15	1.45		1.45	1.5
		73	40	„	1.0	-0.16	0.84		0.84	0.8
		110	60	„	1.6	-0.15	1.45		1.45	1.5
		146	80	„	1.6	-0.15	1.45		1.45	1.5
		183	100	„	0.8	-0.16	0.64		0.64	0.6
		219	120	„	1.0	-0.16	0.84		0.84	0.8

No. 357. Indextherm. No. I synes ikke at have kunnet registrere Bundtemperaturen.
The Index-Therm. No. I would seem not to have been able to register the Bottom-Temp.

No. 361. Paaværende Plads usikker; muligens 4′ à 5′ sydligere. Therm. No. 89 har ikke registreret Bundtemperaturen.
Position uncertain; perhaps Latitude given 4′ to 5′ too far north. No. 89 has not registered the Bottom-Temp.

No. 362. Paaværende Plads usikker; muligens 4′—5′ sydligere.
Position uncertain; Latitude perhaps given 4′ to 5′ too far north.

No. 365. Magdalene Bay.

No. 366. Magdalena Bay. Udenfor Vestsiden af Gully Glacier.
Off west side of Gully Glacier.

No. 367, 368, 369 og 370. Paaværende Plads usikker; muligens 4′—5′ sydligere.
Position uncertain; Latitude perhaps given 4′ to 5′ too far north.

No. 369. Therm. No. 89 synes at have registreret Bundtemperaturen for højt.
Therm. No. 89 would seem to have registered the Bottom-Temp. too high.

No. 370. Therm. No. 89 maaske lidt for højt. No. VI har ikke kunnet registrere den højere Temperatur i 50 Fv.
Therm. No. 89 perhaps a little too high. No. VI has not been able to register the higher temperature in 50 fms.

No. 371. Therm. No. 89 for højt.
Therm. No. 89 too high.

No. 372. Therm. No. 89 for højt.
Therm. No. 89 too high.

No.	D	φ λ m	h	Th.	t'	c_s	t_s	c_p	t_r	t
	1878	° '			°				°	°
374.	Aug. 22	78 16	60			°	°	°		
	7.40 p.m.	15 33 E.	0		4.7				4.7	4.7
		110	60	91	0.9	-0.16	0.74		0.74	0.7
375.	Aug. 23	75 30	204							
	12.0 p.m.	15 3 E.	0		4.8				4.8	4.8
		18	10	91	5.4	-0.12	5.28		5.28	5.3
		37	20	I	4.5	+0.07	4.57		4.57	4.6
		91	50	VII	4.05	+0.10	4.15	-0.01	4.14	4.1
		183	100	II	3.2	+0.13	3.33	-0.02	3.31	3.3
		238	130	III	2.6	+0.24	2.84	-0.01	2.83	2.8
	1878	° '			°	°	°	°	°	°
375. f.		311	170	B	218.2		2.13	+0.27	2.40	2.4
		373	204	89	0.7	-0.21	0.49			-0.42
		"	"	B	226.9		-0.82	+0.31	-0.51	
		"	"	I	-0.4	+0.11	-0.29	-0.04	-0.33	

No. 375. Therm. No. 89 har ikke kunnet registrere Bundtemperaturen med vastrukken Kasse. Se Side 16.
Therm. No. 89 has not been able to register the Bottom-Temperature in a water-soaked case. See p. 16.

Resultaterne af Temperaturrækkerne ere fremstillede grafisk i Plade III til VIII. Til mine Studier over Temperaturens Fordeling i Dybet afsatte jeg Tallene i Temperaturrækkerne paa Millimeterpapir, saaledes at Dybderne regnedes nedover, 100 eng. Favne paa en Centimeter (10 Favne = 1 mm.) og stigende Temperatur horizontalt fra venstre til højre, 1 Grad Celsius per en Centimeter. Mellem de saaledes afsatte Punkter droges en Curve, der fremstiller Temperaturens Variation med Dybden. Disse Curver ere gjengivne i Pl. III til VIII i den halve Maalestok, 1 cm. = 200 Favne, 1° C. = 5 mm. Dybdetallene ere Hundreder af Favne. Ovenover hver Curve staar Temperaturrækkens (Lodskuddets) Løbenummer og dens Bredde og Længde. Paa Pl. VIII har jeg tilføjet lignende Temperaturcurver fra de Britiske Expeditioner i Færø-Shetland-Renden med "Porcupine" (P.) "Knight Errant" (K. E.) og "Triton" (T.), fra de danske Expeditioner i Danmark-Strædet med "Fylla" (D.) og fra Weyprechts Expedition (W.) med "Isbjørn" i Østhavet, hvilke ere benyttede sammen med vore egne til Constructionen af Temperatur-Snittene, der senere ville blive beskrevne. Et Kryds i Horizontallinien 0 Fv. betegner Havoverfladens aarlige Middeltemperatur, udtaget efter Kartet Pl. XVI. Temperaturrækkerne, der alle ere tagne om Sommeren, vise som Regel paa denne Aarstid en rask Aftagen af Temperaturen med Dybet i de øverste Lag. Efter denne følger gjerne en langsommere Aftagen, der i større Dyb afløses af en raskere, men paa meget store Dyb er Temperaturen kun ganske langsomt aftagende med Dybden, ligesom den selv er lav, under Nul Grader. Temperaturens Forhold i Dybet paa det enkelte Sted vil bedst forstaaes efter de nedenfor givne Fremstillinger af dens Fordeling i vertical og horizontal Retning.

3. Temperaturens verticale Fordeling.

Paa Plade IX til XV er Temperaturens Fordeling i vertical Retning vist i 32 Tversnit. Den horizontale Maalestok i disse er den samme som paa Dybdekartet, Pl. I

The results of the serial temperatures are represented diagrammatically, in Plates III to VIII. For prosecuting my researches on the distribution of temperature in the deep, I set down the figures of the serial temperatures on ruled paper (millimetre-paper), in such manner that the depths were counted vertically, 100 English fathoms to a centimetre (10 fathoms = 1 mm.), and rising temperatures horizontally, from left to right, 1 degree centigrade to a centimetre. Between the points thus set off was drawn a curve, representing the variation of temperature with depth. These curves are given in Pls. III to VIII, half the original size; 1 cm. = 200 fathoms, 1° C. = 5 mm. The figures of depth stand for hundreds of fathoms. Above every curve is placed the number of the serial temperature (that of the sounding) along with the latitude and longitude. On Plate VIII, I have annexed similar curves of temperature: from the British Expeditions in the Færoe-Shetland Channel, viz., with the "Porcupine" (P), the "Knight Errant" (K. E.), and the "Triton" (T.); from the Danish Expeditions in Denmark Strait, with the "Fylla" (D); and from Weyprecht's Expedition (W) in the Barents Sea, with the "Isbjørn," all of which have been used, together with our own, for constructing the sections of temperature, to be described farther on. A cross on the horizontal line 0 fathoms, indicates the mean annual temperature of the surface of the sea, as shown by the chart, Pl. XVI. The serial temperatures, all of which were taken in summer, show, as a rule at that time of year, a rapid diminution of temperature with depth in the uppermost strata. To this mostly succeeds a slower decrease, a more rapid following in greater depths, though the temperature in very great depths is found to diminish but slowly with the depth; besides it is low, under zero. The relation of temperature to depth in any given place will be best understood from the description, given below, of its distribution in a vertical and horizontal direction.

3. Vertical Distribution of Temperature.

Plates IX to XV show the vertical distribution of the temperature in 32 transverse sections. The horizontal standard in these sections is the same as that in the Map

(1 : 7000000), hvor ogsaa Snittenes geografiske Beliggenhed med tilsvarende Numer er angivet. Den verticale Maalestok i Snittene er 5 Millimeter paa 100 Favne, eller, da 1 eng. Favn er lig 1.82877 Meter, 5 : 182877 eller 1 : 36575. Maalestokken for Dybderne forholder sig saaledes til Maalestokken for Horizontalafstandene som 7000000 til 36575 eller som 191.4 til 1.

Til Constructionen af Verticalsnittene er der benyttet de samme Lodskud som til Dybdekartet, Pl. I, med tilhørende Bundtemperaturer, og de i Pl. III til VIII fremstillede Temperaturrækker. Isothermobatherne i Verticalsnittene ere bragte i Overensstemmelse med Kartet, Pl. XVI, over Havoverfladens aarlige Middeltemperatur, samt med Karterne, Pl. XVII til XXV, over Temperaturens Fordeling i 100, 200, 300, 400, 500, 600, 1000, 1500 Favnes Dyb og ved Havbunden.

Ovenover Lodskuddene er angivet deres Løbenumer. Til Venstre staar Dybdeskalaen, hvis Tal betegne Hundreder af Favne. Paa Tversnittene, der gaa nogenlunde lodret paa Meridianerne, er nedenunder anbragt en Skala for Længdegrader og Endestationernes Bredde anført. Paa Længdesnittene, der gaa langs Meridianer (Pl. XIV og XV samt XXVI), er øverst anbragt en Skala for Breddegrader. Paa de Snit (Pl. IX), der gaa omtrent i 45° Vinkel med Meridianerne, er Endestationernes Bredde og Længde angivet nedenunder. Curverne i Tversnittene ere Isothermer i Verticalplanet eller, som de ogsaa kaldes, Isothermobather for hver hel Grad Celsius. I de dybere Lag ere Isothermobather angivne, med prikkede Linier for — 0°.5 og for hver Tiendedel Grad under — 1°.

Tversnittet I (Pl. IX) gaar fra Porcupines Station No. 87, i 59° 35′ N. Br., 9° 11′ W. Længde, i en Bue over den søndre Side af Wyville Thomson-Ryggen og Færø-Shetland-Renden, og videre gjennem dennes Axe til vor Station No. 52 i 65° 47′ N. Br., 3° 7′ W. Længde.

Paa den sydvestre Side — Atlanterhavssiden — af Wyville Thomson-Ryggen har man Varmegrader, med temmelig jevnt aftagende Temperatur fra Overfladen til Bunden. Paa den nordostlige Side af samme Ryg er Temperaturens Fordeling en anden. Varmegrader findes kun mellem Overfladen og et Dyb af 300—400 Favne. Under dette Lag findes alene Kuldegrader. Isothermobatherne fra 8° til 0° ligge meget tæt og betegne en rask Aftagen af Temperaturen med Dybden, eller en sterk Afkjøling fra neden opover. I de øverste Lag er Temperaturens Aftagen med Dybden svagere, og i de dybere Lag, hvor der hersker Kuldegrader, er den meget langsom. Den laveste Temperatur ved Bunden naar neppe — 1°.2. Indenfor Færø-Shetland-Rendens Omraade have Isothermobatherne over 0° en Helding mod Sydvest, eller, jo længere man kommer mod Nordost, i desto højere Niveauer ligge de respective Temperaturer.

of Depth, Pl. I (1 : 7000000), where, too, the geographical position of the sections, with the corresponding number, is given. The vertical scale in the sections is 5 millimetres to 100 fathoms, or as 1 English fathom equals 1.82877 metre, 5 : 182877, or 1 : 36575. The standard for depth bears accordingly to the standard for horizontal distances the relation of 7000000 to 36575, or of 191.4 to 1.

For constructing the vertical sections, the same soundings have been used as for the Map of Depth, Pl. I, with the bottom-temperatures, and the serial temperatures represented in Plates III to VIII. The isothermobaths in the vertical sections have been made to agree with the map, Pl. XVI, showing the mean annual temperature of the sea-surface, as also with the maps, Plates XVII to XXV, showing the distribution of temperature at a depth of 100, 200, 300, 400, 500, 600, 1000, 1500 fathoms, and at the bottom of the sea.

Above the soundings, is given the number of each. On the left we have the scale of depth, the figures indicating hundreds of fathoms. Below the transverse sections, which extend nearly perpendicular to the meridians, a scale has been placed for the degrees of longitude, and the latitude of the terminal Stations set down. Above the the longitudinal sections, that pass along the meridians (Pls. XIV, XV, and XXVI), is placed a scale for the degrees of latitude. In the sections (Pl. IX) extending at about an angle of 45° with the meridians, the latitude and longitude of the terminal Stations is given below. The curves in the transverse sections are isotherms in the vertical plane, or, as likewise termed, isothermobaths, for every whole degree centigrade. In the deeper strata, the isothermobaths are indicated by dotted lines for — 0°.5 and for every tenth of a degree below — 1°.

Section I (Pl. IX) extends in a curve from the "Porcupine" Station No. 87, in lat. 59° 35′ N, long 9° 11′ W, across the south side of the Wyville-Thomson Ridge and the Færoe-Shetland Channel, passing on, through the axis of the latter, to Station No. 52, in lat. 65° 47′ N, and long 3° 7′ W.

On the south-western, or Atlantic, side of the Wyville-Thomson Ridge, the temperature is above zero, and gradually diminishes from the surface to the bottom. On the north-eastern side of the same ridge, the distribution of temperature is a different one. Temperatures above zero are observed only between the surface and a depth of 300—400 fathoms. Below that stratum occur only temperatures below zero. The isothermobaths from 8° to 0° lie very close, and indicate a rapid diminution of temperature with depth, or a very considerable cooling from below upwards. In the uppermost strata, the decrease of temperature with depth is less rapid, and in the deeper strata, where degrees below zero are found to prevail, it is very slow. The lowest temperature at the bottom reaches hardly — 1°.2. Within the limits of the Færoe-Shetland Channel, the isothermobaths above 0° exhibit a decline towards the south-west, or, the greater the

Tversnit II gaar fra Knight Errant Station No. 32 imod Nordost over Wyville Thomson-Ryggen langs Axen af Færø-Shetland-Ryggen til Porcupine Station No. 64, altsaa kun lidt i Nordvest for Tversnit I, men mere retliniet end dette. Det viser en Temperaturfordeling, der er saagodtsom den samme som i Tversnit I. Kun synes 0^0 at række lidt dybere paa Nordostsiden af Wyville Thomson-Ryggen.

Tversnit III udgaar fra samme Punkt som Tversnit I, men er lagt over den nordvestre Del of Wyville Thomson-Ryggen, hvor denne har en liden Indsænkning, imod Nordost over Færø-Shetland-Rendens nordvestre Dybdeparti til Porcupines Station No. 64 midt i Renden. I det væsentlige er Temperaturens Fordeling her den samme som i de to første Tversnit. Paa Kammen af Ryggen er 8^0 Varme. Idet denne her ligger paa et noget større Dyb, 320 Favne, og 0^0 ligger allerede i 360 Favnes Dyb, trænge Isothermobatherne sig paa Nordostsiden af Ryggen meget sterkt sammen.

Tversnit IV gaar fra samme Udgangspunkt som de forrige. mod NNE over den nordvestlige Ende af Wyville Thomson-Ryggen, Færø-Bankerne og Færøerne til vor Station No. 52 mellem Island og Norge. Paa Atlanterhavssiden af Ryggen er Varmegrader til Bunds, paa Nordhavssiden Kuldegrader i Dybet under 300 Favne. Over Ryggen selv løfte Isothermobatherne sig opad. Over Færø-Bankerne er Varmegrader, omkring 9^0. Paa Nordostsiden af Færøerne er hele Dybet fra mindst 400 Favne optaget af Kuldegrader. Temperaturen -1^0 ligger i et betydeligt Dyb, 1000 til 1200 Favne. Mellem Stationerne No. 40 og 52 løfter Isothermen for 0^0 sig op til 280 Favnes Dybde. Mellem 100 og 200 Favne ligge Isothermerne for 2^0 til 8^0 meget tæt udenfor Færø-Banken.

Tversnit V gaar over den nordvestlige Del af Færø-Island-Ryggen fra Station No. 44 mod Nordost til Station No. 51. I Snittet løfter denne Ryg sig op til 180 Favne. Paa dens atlantiske Side og over dens Kam findes Varmegrader fra Overfladen til Bunden, og Isothermerne for 4^0 til 7^0 følge dens Skraaning. I de øvre Lag er koldere Vand spredt udover varmere Vand i Dybet. Paa Nordostsiden af Ryggen findes 0^0 allerede i 100 Favnes Dyb og Isothermerne over 1^0 ligge meget tæt henimod Overfladen. Mellem Stationerne No. 47 og 48, paa Skraaningen strax i Nordost for Kammen, staa Isothermerne forholdsvis stejle, og meget tæt, og betegne en sterk Afkjøling i Retning fra Nordost mod Sydvest.

Tversnit VI gaar i Retningen fra Nordvest mod Sydost, fra Færøerne til Shetland, tvers over Færø-Shetland-

distance traversed towards the north-east, the higher are the levels on which lie the respective temperatures.

Section II extends from the "Knight Errant" Station No. 32 towards the north-east, across the Wyville-Thomson Ridge, along the axis of the Færoe-Shetland Ridge to the "Porcupine" Station No. 64 — hence only a little to the north-west of Section I, but more in a straight line than the latter. It exhibits a distribution of temperature well-nigh the same as in Section I, saving that 0^0 would seem to reach somewhat deeper down on the north-east side of the Wyville-Thomson Ridge.

Section III commences at the same point as Section I, but is laid across the north-western part of the Wyville-Thomson Ridge, where the latter has a slight depression, towards the north-east, across the deep, north-western part of the Færoe-Shetland Channel, to the "Porcupine" Station No. 64, in the middle of the channel. As to all essential particulars, the distribution of temperature here is the same as in the two first sections. On the crest of the ridge, the temperature is 8^0 above zero. The ridge lying here at a somewhat greater depth, 320 fathoms, and 0^0 occurring at a depth of only 360 fathoms, the isothermobaths on the north-east side of the ridge crowd very closely together.

Section IV extends from the same point as the preceding, towards the NNE, across the north-western end of the Wyville-Thomson Ridge, the Færoe Banks and the Færoe Islands to Station No. 52, between Iceland and Norway. On the Atlantic side of the ridge, the temperature is above zero from the surface to the bottom, on the North Ocean side, below zero from a depth of 300 fathoms to the bottom. Over the ridge itself, the isothermobaths rise upwards. Above the Færoe Banks, the temperature is upwards of 0^0, about 9^0. On the north-eastern side of the Færoe Islands, the whole of the deep, at least from 400 fathoms downwards, has a temperature below zero. The temperature -1^0 does not occur till at a very considerable depth, 1000 to 1200 fathoms. Between the Stations No. 40 and No. 52, the isotherm for 0^0 rises to a depth of 280 fathoms. Between 100 and 200 fathoms, the isotherms for 2^0 to 8^0 lie very close off the Færoe Bank.

Section V extends across the north-western part of the Færoe-Iceland Ridge, from Station No. 44, towards the north-east, to Station No. 51. In the section, this ridge rises to 180 fathoms. On the Atlantic side, and above its crest, the temperature is upwards of 0^0 from the surface to the bottom; and the isotherms for 4^0 to 7^0 follow its slope. In the upper strata, comparatively cold water extends over water of a higher temperature throughout the deeper parts. On the north-east side of the ridge, 0^0 occurs at a depth of only 100 fathoms, and the isotherms above 1^0 lie very close as they approach the surface. Between the Stations No. 47 and No. 48, on the slope immediately north-east of the crest, the isotherms have a relatively upright position, lie very close, and indicate a considerable decrease of temperature from the north-east to the south-west.

Section VI extends from the north-west towards the south-east, from the Færoes to the Shetlands, straight

Renden, gjennem Porcupines Station No. 64. Isothermobatherne bero her udelukkende paa Porcupine-Observationer. i Midten paa Temperaturrække, paa begge Sider kun paa Bundtemperaturer i Nærheden af Snittet i de respective Dybder. Isothermerne for 1^0 til 7^0 helde i den østlige Halvdel sterkt mod Shetlandsbanken. Her er altsaa det varmeste Vand ophobet. Isothermen for 0^0 har en lignende, men svagere Heldning. Den ligger i Midten paa 320 Favnes Dyb. Isothermen for — 1^0 derimod sænker sig i Midten og løfter sig paa begge Sider. Det koldeste Vand drager sig saaledes op over Skraaningerne paa begge Sider.

Tversnit VII gaar fra Station No. 94, ved Udsire, langs den norske Rende mod NNW til Station No. 34 i Nordhavet. Fra den norske Rende i Skagerak, hvor der i Dybet er en constant Temperatur af 5^0, stiger Bundtemperaturen mod Nord med stigende Dybde indtil Station 12, hvor den naar et Maximum af $6^0.3$, for derfra at aftage videre mod Nord. Samtidig viser Overfladetemperaturen for Aaret en lignende Gang. Isothermerne 6^0 til 9^0 sænke sig mod Bundtemperaturens Maximums Plads. Paa Rendens Affald mod Dybet findes 0^0 i 350 Favnes Dyb og lidt længere ude, i Station No. 18, i 300 Favnes Dyb. Isothermen for — 1^0 (— $0^0.95$) drager sig opad langs Bunden.

Tversnit VIII. Pl. X, gaar fra Island (Berufjord, Papey) mod Øst i en svag Bue til Christiansund. I Midten stikker Færø-Banken op, og udenfor Christiansund, mellem Stationerne 32 og 26 sees den bratte Skraaning udenfor Storeggen. I dette og alle de følgende Snit indtage Kuldegrader alle de dybere Lag. I den vestlige Halvdel er der Varmegrader paa Island-Færø-Ryggen. Østenfor denne gaar 8^0 merkelig langt ned i Dybet, men i de øverste Lag er mindre varmt Vand. Omtrent over Færø-Bankens Afheld stige Isothermerne noget opad. I den østlige Halvdel sænke de sig idetheletaget henimod Norges Kystbanker. Paa disse er Varmegrader, men det er mindre varmt inde under Land end ude paa Banken (Storeggen). Isothermen for 0^0 ligger højest (240 Favne) paa Island-Færø-Ryggen og ved Station No. 34 i den østlige Del (280 Fv.) Den sænker sig til 400 Favne ved Station No. 41 i Vest og paa Skraaningen udenfor Storeggen. Isothermen for — 1^0 sænker sig ned i Dybet nordenfor Færøerne, men holder sig paa den vestlige Side af Indløbet til Færø-Shetland-Renden. Mellem Mundingen af den norske Rende og Storeggens Yderskraaning ligger den langs Bunden.

Tversnit IX ligger paa den 64. Breddegrad og gaar over Fro-Øerne. Man gjenfinder de samme Træk som i det foregaaende Tversnit. I den Fordybning, som Fro-

across the Færoe-Shetland Channel, through the "Porcupine" Station 64. The isothermobaths are based here exclusively on "Porcupine" observations, in the middle consisting of serial temperatures, on either side of bottom-temperatures alone, taken near the section in the respective depths. The isotherms 1^0 to 7^0 incline considerably throughout the eastern half towards the Shetland Bank. Here, accordingly, the warmest water is found to accumulate. The isotherm for 0^0 has a similar though less rapid incline. In the middle part it lies at a depth of 320 fathoms. The isotherm for — 1^0, on the other hand, sinks in the middle and rises on either side. Hence the coldest water makes its way up both sides of the slopes.

Section VII extends from Station No. 94, at Udsire, along the Norwegian Channel, towards the NNW, as far as Station 34, in the North Ocean. From the Norwegian Channel, in the Skagerak, where the deep has a constant temperature of 5^0, the bottom-temperature rises towards the north with increasing depth as far as Station 12, at which point it reaches a maximum of $6^0.3$, and then falls off towards the north. At the same time the annual surface-temperature exhibits a similar variation. The isotherms for 6^0 to 9^0 sink in the direction where the bottom-temperature has its maximum. On the slope of the channel towards the deep, 0^0 occurs at a depth of 350 fathoms, and a little farther out, Station No. 18, at a depth of 300 fathoms. The isotherm for — 1^0 (— $0^0.95$) makes its way upwards along the bottom.

Section No. VIII, Pl. X, extends from Iceland (Berufjord, Papey) towards the east, in a faint curve, as far as Christiansund. In the middle part, the Færoe Bank juts up, and off Christiansund, between Stations 32 and 26, may be seen the precipitous slope off the Storeg. In this and all the following sections, temperatures below 0^0 occur throughout all the deeper strata. In the western half, temperatures above 0^0 are observed on the Iceland-Færoe Ridge. East of the latter, 8^0 descends to a remarkable depth; but in the uppermost strata the water is less warm. Very nearly above the decline of the Færoe Bank, the isotherms exhibit an upward tendency. In the eastern half, they sink as a rule in the direction of Norway's coastal banks. Over these occur temperatures above zero; but the temperature is not so high near land as out on the bank (the Storeg). The isotherm for 0^0 lies highest (240 fathoms) on the Iceland-Færoe Ridge, and at Station No. 34, in the eastern part (280 fathoms). It sinks to a depth of 400 fathoms at Station 41, located west, and on the slope off the Storeg. The isotherm for — 1^0 sinks down into the deep north of the Færoes, but keeps on the western side of the entrance to the Færoe-Shetland Channel. Between the mouth of the Norwegian Channel and the outer slope of the Storeggen Bank, it extends along the bottom.

Section IX lies on the 64th parallel of latitude, and passes across the Fro Islands. We meet with she same characteristics as in the preceding transverse section.

Havet danner indenfor Fro-Øerne, findes i Dybet en Temperatur af 7°, medens det under Land er koldere.

Tversnit X gaar fra Langanes, Islands Nordostpynt, tvers over det norske Hav til Foldenfjorden. Den højeste Varmegrad i Overfladen, over 8°, findes over de norske Kystbanker, den laveste, 2°, østenfor Island. Paa den norske Side bliver det koldere under Land (6.°6), paa Islandssiden varmere. Over hele Snittet trænge Varmegradsisothermerne sig sammen i de øvre Vandlag. Nul Grad ligger dybest (400 Favne) midt i Snittet og kun lidt højere i dets østlige Del. Henimod Island derimod løfter Isothermen for 0° sig til 200 Favne ved Station No. 51 og her raskt op til mindre end 100 Favnes Dyb. (Sml. Tversnit V). Henimod Islands-Banken synker den atter noget dybere, til 200 Favne. Isothermen for — 1° ligger dybt (1200 Favne) i Midten af Snittet og hæver sig paa begge Sider til 400 Favne. Et lignende Løb viser Isothermen for — 1°.1. Den laveste Temperatur i Snittet, — 1°.2 til — 1°.3, holder sig hovedsagelig paa den østlige Skraaning, hvor den stiger op fra 1700 til 600 Favne, men forekommer ogsaa paa den vestlige. I Indsænkningen udenfor Island er af Danskerne observeret — 1°.2.

Tversnit XI gaar fra Station No. 96 paa 66° 8′ N. Br. 3° 0′ E. Lg. til den norske Kyst under den 65. Breddegrad. Fraregnet noget lavere Temperatur i de øvre Lag ligner Temperaturens Fordeling her den i det foregaaende Tversnit. Isothermen for 0° løfter sig mod Kysten.

Tversnit XII ligger mellem den 67. og 66. Breddegrad udenfor Helgeland. Merkeligt er her paa Banken et Minimum af Temperatur paa 4.°8 og 4.°9 ved Stationerne 121 og 122. Strax nordenfor dette Sted er der, som Dybdekartet viser, en Indbugtning i Kystbanken.

Tversnit XIII (Pl. XI; den vestlige Del af Snittet i midterste Rad til Venstre) gaar fra Grønland over Jan Mayen-Renden og Norskedybet til den norske Kyst søndenfor Vestfjorden ved Trænan. Den højeste Temperatur, mellem 7° og 8°, findes over og udenfor de norske Kystbanker. Det er koldere under Land, 6°. Varmegradsisothermerne ligge i dette Snit, som i de forrige, temmelig tæt og have i det Hele en svag Heldning mod Norge. Mod Vest løfte de sig, navnlig under 3°, raskere opad. Isothermen for 0° ligger i den østlige Del af det norske Hav paa omkring 400 Favne, eller oftest noget dybere. I Syd for Jan Mayen bøjer den, ligesom de øvrige Isothermer, raskere op mod Overfladen i Jan Mayen-Renden, og skraaner langsomt opad paa en længere Strækning, indtil den i Grønlandshavet nordenfor Island naar Overfladen. Største Delen af Snittet indtages saaledes af iskoldt Vand, med Kuldegrader. Isothermen for — 1° sænker sig til henimod 900 Favne over Norskedybet, og løfter sig paa Østsiden til 400 Favne paa den bratte Skraaning udenfor de norske Kystbanker, paa Vestsiden til Overfladen udenfor Grønland. Isother-

Throughout the depression formed by the Fro Sea within the Fro Islands, the deep part exhibits a temperature of 7°, whereas near land the water is colder.

Section X extends from Langanes, the north-eastern extremity of Iceland, straight across the Norwegian Sea, to the Foldenfjord. The highest temperature at the surface, above 8°, occurs over the Norway coastal banks, the lowest, 2°, east of Iceland. On the Norwegian side, the water gets colder towards land (6.°6), on the Iceland side warmer. Over the whole section, the isotherms for the higher temperatures crowd together in the upper strata. The temperature 0° lies deepest (400 fathoms) in the middle of the section, and but little higher throughout its eastern part. Towards Iceland, on the other hand, the isotherm for 0° rises to 200 fathoms, at Station No. 51, and there reaches rapidly a depth of less than 100 fathoms (See Section V). Near the Iceland Bank it sinks somewhat deeper down, to 200 fathoms. The isotherm for — 1° lies deep (1200 fathoms) in the middle of the section, rising up on either side to 400 fathoms. A similar course characterises the isotherm for — 1°.1. The lowest temperature in the section, — 1°.2 to — 1°.3, keeps principally on the eastern slope, where it rises from 1700 up to 600 fathoms, but is also met with on the western. In the depression off Iceland, the Danish explorers observed — 1°.2.

Section XI extends from Station No. 96, in lat. 66° 8′ N, long. 3° 0′ E, to the coast of Norway, on the 65th parallel of latitude. Apart from a somewhat lower temperature in the upper strata, the distribution of temperature here resembles that in the preceding section. The isotherm for 0° rises towards the coast.

Section XII lies between the 67th and 66th parallels, off Helgeland. We observe here on the bank a remarkable minimum of temperature, 4°.8 and 4°.9 at Stations 121 and 122. Immediately to the north of this locality, there is, as shown by the Map of Depths, an incurvation along the coastal bank.

Section XIII (Pl. XI; the most westerly part of the section in the middlemost row to the left) extends from Greenland across the Jan-Mayen Channel and the Norway Deep as far as the Norwegian coast, south of the Vestfjord, at Trænan. The highest temperature, between 7° and 8°, occurs above and off the Norway coastal banks. The water is colder inshore, 6°. The isotherms for temperatures above 0° lie in this section, as in the others preceding it, rather close, and exhibit on the whole a faint incline towards Norway. Westward, in particular below a temperature of 3°, they rise more abruptly upwards. The isotherm for 0° lies in the eastern part of the Norwegian Sea, at a depth of close upon 400 fathoms, or, as a rule, somewhat deeper. South of Jan Mayen, it curves, in common with the other isotherms, more rapidly towards the surface in the Jan-Mayen Channel, sloping gradually up for a considerable distance, till, north of Iceland, in the Greenland Sea, it reaches the surface. Hence, the greater part of the section contains ice-cold water, below 0°. The isotherm for — 1° sinks, above the Norway Deep, to well-nigh 900 fathoms, rising on

merne for — 1°.1 og — 1°.2 følge et lignende Løb i større Dybder. Isothermen for — 1°.3 findes i Jan Mayen-Renden og Grønlandshavet, samt paa den norske (østre) Side af Norskedybet og i den dybe nordenfra indskjærende Bugt udenfor de norske Kystbanker ved Sydenden af Vesteraalseggen. Paa den vestre Skraaning af Norskedybet er Temperaturen ikke under — 1°.3. I Grønlandshavet findes rimeligvis, efter de danske Observationer i Nord for Island at dømme (Snit XXXII, Pl. XIV), — 1°.6.

Tversnit XIV gaar mellem den 68. og 67. Breddegrad over Røst, den yderste af Lofotens Øer, og Mundingen af Vestfjorden. Det viser den sydlige Del af Vesteraalseggen i Profil. Her findes 0° i 400 Favnes Dyb og — 1° i 450. Mellem 0° og 5° ligge Isothermerne meget tæt. Isothermen for 6° udviser en poseformet Nedsænkning udenfor Eggen af Banken. Paa Landsiden omslutter saavel udenfor som indenfor Røst, det er, i Vestfjorden, Isothermen for 5° et Temperaturminimum, der ude paa Banken vestenfor Røst ligger ved Bunden med c. 4°.5 Varme, men i selve Vestfjorden har varmere Vand saavel over som under sig. Vestfjordens Bundtemperatur (Station No. 255) og Overfladens aarlige Middeltemperatur er omkring 6°, (Pl. XVI) medens der i 60 Favnes Dyb er et Minimum paa omkring 4°.5 (Stat. No. 148, 254 og 255).

Tversnit XV gaar fra Grønland (71° 20′) over Grønlandshavet, Jan Mayen, Lofotdybet og Vesteraalseggen til Vesteraalen (69°). Den højeste Temperatur er mellem 6° og 7°. Alle Varmegradsisothermer sænke sig mod Dybet udenfor Vesteraalseggen og midtvejs mellem Norge og Jan Mayen. De hæve sig mod Eggen og i endnu højere Grad mod Vest, navnlig de for 0°, 1°, 2° og 3°. Varmegradsisothermerne ligge mindre tæt end søndenfor. Temperaturen i Overfladen er forholdsvis lavere og Nulgradsisothermen ligger dybere, idet den paa sine dybeste Punkter naar ned til 660 Favne, hvilket er mindst 200 Favne dybere end i Tversnit XIII. Østenfor Jan Mayen gaar Isothermen for 0° raskt tilvejrs og naar Overfladen; fra denne til Bunden er iskoldt Vand. Isothermen for — 1°, der i Station 183 naar sit største Dyb, 1100 Favne, stiger til begge Sider. Østenfor Jan Mayen danner den i de øvre Lag, 20 til 120 Favne, en afsluttet Curve, der indeslutter et Minimum af Temperatur paa indtil — 1°.7 (Stat. 217 og følgende); i de dybere Lag omslutter den et dybere liggende Minimum paa mindst — 1°.3. Lige under Østkysten af Jan Mayen er Temperaturen forholdsvis højere (Stat. 226, 222). Vestenfor Jan Mayen er lutter Kuldegrader, og i større Dyb ned til — 1°.5. Isothermen for — 1°.2 naar ikke Dybet mellem Jan Mayen og Norge. Her er ved Bunden et Temperaturmaximum paa — 1°.17 (Stat. 213). Isothermen for — 1°.3 findes omkring Jan Mayen, samt paa Skraaningen paa Dybets vestre Side og paa Bunden paa dets østre Side,

the eastern side to 400 fathoms along the steep declivity off the Norway coastal banks, on the western to the surface, off Greenland. The isotherms for — 1°.1 and — 1°.2 take a similar course in greater depths. The isotherm for —1°.3 is met with in the Jan-Mayen Channel and the Greenland Sea, as also on the Norwegian (eastern) side of the Norway Deep, and in the deep bay extending from the north off the Norwegian coastal banks at the southern extremity of the Vesteraalseg. On the western declivity of the Norway Deep, the temperature is not under — 1°.3. In the Greenland Sea, judging from the Danish observations taken north of Iceland (Section XXXII, Pl. XIV), — 1°.6 most probably occurs.

Section XIV extends from between the 68th and 67th parallels of latitude across Røst, the outermost of the Lofoten Islands, and the mouth of the Vestfjord. It shows the southern part of the Vesteraalseg in profile Here 0° occurs at a depth of 400 fathoms, and — 1° at a depth of 450. Between 0° and 5° the isotherms lie exceedingly close. The isotherm for 6° exhibits a sac-like depression off the edge of the bank. On the land-side, the isotherm for 5° encloses both without and within Røst, i. e. in the Vestfjord, a minimum of temperature, which lies, out on the bank west of Røst, at the bottom, with a temperature of about 4°.5, but in the Vestfjord itself has warmer water both above and below. The bottom-temperature in the Vestfjord (Station No. 255) and the annual mean temperature at the surface is about 6° (Pl. XVI), whereas in 60 fathoms there is a minimum of about 4°.5 (Stations No. 148, 254, and 255).

Section XV extends from Greenland (71° 20′) across the Greenland Sea, Jan Mayen, the Lofoten Deep, and the Vesteraalseg to Vesteraalen (69°). The highest temperature is between 6° and 7°. All isotherms for a temperature above 0° sink towards the deep off the Vesteraalseg and midway between Norway and Jan Mayen. They rise towards the edge of the bank and still more so towards the west, in particular those for 0°, 1°, 2°, and 3°. The isotherms for a temperature above 0° lie less close than farther south. The temperature at the surface is relatively lower, and the isotherm for 0° lies deeper, reaching at its deepest points 660 fathoms, or at least 200 fathoms deeper than in Section XIII. East of Jan Mayen, the isotherm for 0° juts abruptly up, and reaches the surface, whence ice-cold water extends to the bottom. The isotherm for — 1°, which sinks to its greatest depth, 1100 fathoms, at Station No. 183, rises on either side. East of Jan Mayen, it forms in the upper strata — from 20 to 120 fathoms — a closed curve, which encompasses a minimum of temperature, reaching — 1°.7 (Stations 217 and following); in the deeper strata, it encloses a deeper-lying minimum of at least —1°.3. Immediately adjacent to the east coast of Jan Mayen, the temperature is relatively higher (Stats. 226, 222). West of Jan Mayen, occur exclusively degrees below 0°, and in greater depths a temperature as low as — 1°.5. The isotherm for — 1°.2 does not reach the deep between Jan Mayen and Norway. Here is found at the bottom a maximum-temperature of

men begge Steder kun over mindre Strækninger. Den naar ikke op over Vesteraalseggen.

Tversnit XVI gaar mellem den 71. og 70. Breddegrad udenfor Tromsø. Paa Banken er i 130 Favnes Dyb en Temperatur af 6°, medens der under Land kun er 5°. Nul Graders Isothermen ligger i 570 Favnes Dyb. Isothermen for — 1° stiger op mod Bankens Yderskraaning til 700 Favne.

Tversnit XVII (Pl. XII øverst og i anden Rad til Venstre) gaar fra Grønland (73° N. Br.) over Tverryggen til Loppen (Finmarkens Sydgrændse, 70° 20′ N. Br.). Den højeste Temperatur, over 5°, findes i de øverste Lag i Snittets østligste Del, udenfor og over de norske Kystbanker. Udenfor disse sænke Varmegradsisothermerne sig dybest ned. Isothermen for 0° rækker ned til 580 Favne. Mellem Stationerne 296 og 297 løfter den og de øvrige Isothermer sig raskt op mod Overfladen. Vestenfor Station 297 skyder sig i 40 til 50 Favnes Dyb en Kile med et Temperaturminimum paa — 1°.3 ind mellem de over- og underliggende varmere Vandlag. Først i meget større Dyb kommer atter Isothermen for — 1° tilsyne, i det hele taget med lignende Bøjninger som den for 0°. I den vestlige Del af Snittet, i Grønlandshavet, optræder — 1°.5 og — 1°.6.

Tversnit XVIII følger omtrent den 74. Breddegrad søndenfor Beeren-Eiland. Det viser Overgangen fra Nordhavs-Dybet til Østhavet. Vestenfor Beeren-Eiland sænke Isothermerne sig mod Vest. Allerede i 400 Favnes Dyb have vi 0° paa Skraaningen. Østenfor Beeren-Eilands-Banken er Temperaturen paa en lang Strækning højere i 100 Favne end i Overfladen, idet Isothermen for 2° indeslutter et Maximum i Dybet. Ellers aftager Temperaturen mod Øst og mod Dybet. Nul Grad viser sig ved Station 275.

Tversnit XIX gaar fra Grønland (74°.5) mod Øst og langs den 75. Breddegrad til Beeren-Eilands-Banken. I Dybet træffe vi den merkelige ovenfor, Side 5 f, omtalte Forhøjning paa Havbunden. Den højeste Temperatur, over 4°, ligger i Vest for Beeren-Eilands-Banken, over dennes ydre Skraaning. I Overfladen er det her mindre varmt end i 100 Favnes Dyb. Under dette Temperaturmaximum buge alle Dybets Isothermer sig nedad. De stige op langs Banken og mod Grønlandshavet, i hvilket den laveste observerede Havtemperatur i Dybet, — 1°.7, optræder. Nulgradsisothermen stiger paa Banken til 400 Favne; udenfor gaar den ned til 560 Favne.

Tversnit XX gaar fra Station 332 til 326, fra WNW til ESE mellem Spidsbergen og Beeren-Eiland, fra Nordhavsdybet til Østhavet. Udenfor Bankens Eg er Temperaturens Maximum ikke i Overfladen, men nærmere ved 100 Favnes Dyb. Nul Grad træffes i 480 Favnes Dyb. Det

— 1°.17 (Station 213). The isotherm for — 1°.3 occurs round Jan Mayen, as also along the slope on the western side of the deep, and at the bottom on its eastern side; but in both localities throughout confined tracts only. It does not reach up above the Vesteraalseg.

Section XVI extends from between the 71st and 70th parallels of latitude, off Tromsø. On the bank, at a depth of 130 fathoms, there is a temperature of 6°, while, close to land, 5° only occurs. The isotherm for 0° lies at a depth of 570 fathoms. That for — 1° rises towards the outer slope of the bank up to 700 fathoms.

Section XVII (Pl. XII; first and second row to the left) extends from Greenland (lat. 73° N) across the Transverse Ridge to Loppen (southern extremity of Finmark, lat. 70° 20′ N). The highest temperature, over 5°, occurs in the upper layers of the eastern part of the section, off and above the Norwegian coastal banks. Without the latter, the isotherms for degrees above 0° sink deepest. The isotherm for 0° reaches down to 580 fathoms. Between Stations 296 and 297, this and the other isotherms rise up rapidly towards the surface. West of Station 297, at a depth of 40 to 50 fathoms, a wedge-like mass of water, with a minimum-temperature of — 1°.3 lies between the upper and lower strata of warmer water. Not till it reaches a very considerable depth can the isotherm for — 1° again be observed, on the whole with curvatures similar to that for 0°. Throughout the western part of the section, in the Greenland Sea, occur — 1°.5 and — 1°.6.

Section XVIII extends along the 74th parallel of latitude, south of Beeren Eiland. It shows the transition from the North-Ocean Deep to the Barents Sea. West of Beeren Eiland, the isotherms sink towards the west. At a depth of not more than 400 fathoms, we have 0° on the slope. East of the Beeren-Eiland Bank, the temperature is higher for a very considerable distance at a depth of 100 fathoms than at the surface, since the isotherm for 2° encloses a maximum in the deep. Besides, the temperature diminishes towards the east and towards the deep. A temperature of 0° is met with at Station 275.

Section XIX extends from Greenland (74°.5) towards the east, passing along the 75th parallel of latitude to the Beeren-Eiland Bank. In the deep we find the singular eminence mentioned above, p. 5 f, rising from the sea-bed. The highest temperature, more than 4°, occurs west of the Beeren-Eiland Bank, over its outer declivity. At the surface, the water is not so warm as at a depth of 100 fathoms. Below this maximum of temperature, all deep-lying isotherms curve downwards. They rise along the bank and towards the Greenland Sea, in which the lowest sea-temperature observed in the deep, — 1°.7, is found to occur. On the bank the isotherm for 0° rises to 400 fathoms, *off* it reaching not higher than up to 560 fathoms.

Section XX extends from Station 332 to Station 326, or from WNW to ESE, between Spitzbergen and Beeren Eiland, from the North-Ocean Deep to the Barents Sea. Off the edge of the bank the maximum-temperature does not occur at the surface, but nearer a depth of 100 fathoms.

merkeligste i dette Snit er et Temperatur-Minimum paa — 1°.3 inde paa Banken, omgivet paa begge Sider af Varmegrader. Dette er Tversnittet gjennem en Tunge af iskoldt Vand, der langs Bunden skyder sig frem fra Storfjorden østenfor Spidsbergens Sydkap, som Kartet over Bundtemperaturerne (Pl. XXV) viser.

Tversnit XXI gaar fra SW mod NE mellem den 75. og 76. Breddegrad søndenfor Spidsbergens Sydkap fra Nordhavsdybet til Storfjorden. Det gaar langs Længdeaxen af den under forrige Tversnit omtalte iskolde Kile. En Temperaturrække af Weyprecht udenfor Sydkap (W) s utter sig ganske til de norske. Maximumstemperaturen, over 4°, ligger under Overfladen. Da Bundtemperaturerne paa Banken, regnet fra NE mod SW, give Tallene — 1°.1, — 1°.3 og — 0°.4 har jeg antaget, at selve Nulgradslinien findes strax udenfor (vestenfor) Station 328, og at den iskolde Kile paa Banken ikke rækker ned i Nordhavsdybets iskolde Vand, hvor 0°, efter Bundtemperaturkartet, først bliver at søge i 500 Favnes Dyb. Formen for Isothermen for 1°, der fjerner sig fra Bankens bratte Skraaning, tyder dog paa, at den kolde Kile fra Storfjorden ved sin Vest-Ende udøver en merkelig Afkjoling, som imidlertid ikke kan antages at bringe Temperaturen paa Banken mellem 220 og 500 Favne helt ned til 0°.

Tversnit XXII, Pl. XIII, gaar fra Grønland (75° N. Br.) over Svenskedybet til Spidsbergens Sydkap. Den højeste Temperatur, 4°, ligger som et afsluttet Parti under Overfladen udenfor Banken. Alle Varmegrader ligge paa Østsiden, ved Spidsbergen. Nul Grad naar ned til 500 Favne. Isothermerne for — 1° til — 1°.4 skyde i de øvre Lag en Tunge østover fra Grønlandshavet. I Svenskedybet er fundet — 1°.5.

Tversnit XXIII gaar fra Grønland (76° 25′ N. Br.) over Svenskedybet til Isfjorden paa Spidsbergens Vestkyst. Den højeste Temperatur, over 3°, ligger over Kystbankens Eg, men under Overfladen. Inde i Isfjorden er det koldere, saavel i Overfladen, som ved Bunden, hvor Kuldegrader træffes. Varmegraderne indtage et indskrænket Rum udenfor Spidsbergen og gaa ned til 500 Favne. Ved Station 351 træffes et løsrevet Parti Vand med Varmegrader i omkring 100 Favnes Dyb. I Grønlandshavets Dyb er Temperaturen under — 1°.5.

Tversnit XXIV gaar over Spidsbergbanken udenfor Prins Charles Foreland langs den 79. Breddegrad. Isothermen for 2° sænker sig udenfor Banken ned til henimod

Zero is met with at a depth of 480 fathoms. The most remarkable characteristic in this section consists of a minimum-temperature, — 1°.3, on the bank itself, shut in on both sides by degrees above 0°. This transverse section cuts through a tongue of ice-cold water, pressing forward along the bottom from the Storfjord, east of the southern extremity of Spitzbergen, as shown by the Map of Bottom-Temperatures (Pl. XXV).

Section XXI extends from the SW towards the NE, between the 75th and the 76th parallels of latitude, south of the southern extremity of Spitzbergen, from the North-Ocean Deep to the Storfjord. It passes along the longitudinal axis of the ice-cold wedge alluded to when describing the preceding transverse section. A serial temperature taken by Weyprecht off South Cape, Spitzbergen (W), agrees in every respect with those of the Norwegian explorers. The maximum-temperature, upwards of 4°, lies below the surface. The bottom-temperatures on the bank, from NE towards SW, giving the figures — 1°.1, — 1°.3, and — 0°.4, I have ventured to assume that the line for 0° occurs immediately off (west of) Station 328, and that the ice-cold water on the bank does not reach down into the ice-cold water of the North-Ocean Deep, where 0°, according to the Map of Bottom-Temperatures, does not make its appearance at a depth of less than 500 fathoms. The form of the isotherm for 1°, which extends from the steep declivity of the bank, would seem however to imply that the ice-cold wedge from the Storfjord exerts at its western extremity an appreciable cooling influence, but which cannot be assumed to bring the temperature on the bank, between 220 and 500 fathoms, fully down to 0°.

Section XXII, Pl. XIII, extends from Greenland (lat. 75° N) across the Swedish Deep to the southern extremity of Spitzbergen. The highest temperature, 4°, extending, so to speak, as an isolated patch, lies beneath the surface, off the bank. All degrees above 0° occur on the east side, off Spitzbergen, and 0° reaches down to 500 fathoms. The isotherms for — 1° to — 1°.4 send off eastwards in the upper strata a tongue of water from the Greenland Sea. In the Swedish Deep, a temperature of — 1°.5 has been registered.

Section XXIII extends from Greenland (lat. 76° 25′ N) across the Swedish Deep to Ice Sound, on the west coast of Spitzbergen. The highest temperature, more than 3°, occurs over the edge of the coastal bank, but below the surface. In Ice Sound, some distance from the mouth, the water is colder, both at the surface and at the bottom, where a temperature below 0° is observed. The temperatures above 0° occupy a confined space off the coast of Spitzbergen, and descend to a depth of 500 fathoms. At Station 351 there is an isolated patch of water with a temperature above 0° at a depth of about 100 fathoms. In the Deep of the Greenland Sea the temperature is below — 1°.5.

Section XXIV extends across the Spitzbergen Bank, off Prince Charles Foreland, along the 79th parallel of latitude. The isotherm for 2° sinks off the bank to a depth

300 Favnes Dyb. Varmegradernes Omraade er meget indskrænket, men rækker ned til 400 Favne. Mod Vest indtage Isothermerne en næsten vertical Stilling. De indeslutte et Maximum af Varme paa over 3⁰, der ligger under Overfladen.

Tversnit XXV gaar langs den 80. Breddegrad udenfor Nordvest-Spidsbergen. Den højeste Varme findes under Overfladen og naar 3⁰ i 100 Favnes Dyb. Varmegrader række til 400 Favnes Dyb. Dette er det nordligste Tversnit.

Tversnit XXVI gaar fra Spidsbergens Sydkap over Beeren-Eiland til Hammerfest. Det viser Temperaturens Fordeling i den vestlige Del af Østhavet. Den højeste Temperatur træffes i Overfladen udenfor Nordkap, hvor den er over 5⁰. De lavere Isothermer helde mod Norge paa en meget jevn Maade. Under den norske Kyst er det saaledes i alle Dybder varmere end søndenfor Beeren-Eiland, men overalt er der paa denne Strækning Varmegrader. Mellem Beeren-Eiland og Spidsbergens Sydkap se vi ved Bunden den iskolde Kile, der kommer fra Storfjorden, og et Maximum af Temperatur paa over 2⁰ i omkring 60 Fv. Dyb.

Tversnit XXVII gaar fra Vardø mod NE til Novaja Semlja (74⁰ N. Br.). Det viser Temperaturens Fordeling i den østlige Del af Østhavet. Alle Isothermer helde mod Norge. Fra Vardø til den 36. Længdegrad er der Varmegrader ved Bunden. Østenfor er der Kuldegrader, hvilke indtage de dybere Lag og blive herskende udenfor Novaja Semlja.

Tversnit XXVIII, Pl. XIV, gaar langs Greenwichs Meridian fra 61⁰ (Shetland) til 78⁰ N. Bredde. Overfladens Temperatur aftager stadig mod Nord indtil den 77. Breddegrad. Mellem 70⁰ og 73⁰ N. Br. se vi Overfladen lidt koldere end Vandet i 100 Favnes Dyb. Nulgradsisothermen naar under 64⁰ Bredde kun 280 Favne, men gaar herfra mod Dybet, indtil den mellem 70⁰ og 71⁰ naar ned over 600 Favnes Dyb, for videre mod Nord at stige, indtil den ved 77⁰ naar Overfladen. Et løsrevet Stykke med svag Varmegrad findes i 100 Favnes Dyb paa 77⁰ til 78⁰. Isothermen for — 1⁰, der ved 63⁰—64⁰ ligger lidt dybere end 800 Favne, sænker sig til 1000 Favne ved 65⁰—66⁰, stiger til 870 Favne ved 68⁰, synker til henimod 1000 Favne lidt nordenfor 70⁰ og stiger derfra op mod Overfladen under 74⁰ Br. Fra 74⁰ til 73⁰ skyder den i de øvre Lag en Kile sydover og fra 76⁰ til 77⁰ en lignende nordover. Nordenfor 76⁰ se vi den i større Dybder danne en næsten sluttet Curve omkring Varmegradsmaximumet. Mellem den 70. og 71. Breddegrad er der ved Bunden et Varmemaximum, hvor Temperaturen ikke gaar under — 1⁰.17. Mellem 66⁰ og 69⁰ er Bundtemperaturen lavere end — 1⁰.3. Mellem 73⁰ og 76⁰ indtages de dybere Lag, under 1000 Favne, af et Temperaturminimum paa — 1⁰.6.

of close upon 300 fathoms. The temperatures above 0⁰ extend over a very confined space, which reaches however down to 400 fathoms. Towards the west, the isotherms have an almost vertical position. They inclose a maximum of heat, upwards of 3⁰, which lies beneath the surface.

Section XXV extends along the 80th parallel of latitude, off the north-west coast of Spitzbergen. The highest temperature occurs beneath the surface, and reaches 3⁰, at a depth of 100 fathoms. Temperatures above 0⁰ extend down to 400 fathoms. This is the most northerly transverse section.

Section XXVI extends from the southern extremity of Spitzbergen across Beeren Eiland to Hammerfest. It shows the distribution of temperature throughout the western tract of the Barents Sea. The highest temperature occurs at the surface, off the North Cape, where it reaches upwards of 5⁰. The lower isotherms incline towards Norway, very gradually. In immediate proximity to the coast of Norway, the water in all depths is accordingly found to be warmer than south of Beeren Eiland, but degrees above 0⁰ we meet with everywhere throughout that tract. Between Beeren Eiland and the southern extremity of Spitzbergen, occurs the ice-cold wedge at the bottom that has its origin in the Storfjord, and also a maximum of temperature, reaching more than 2⁰, at a depth of about 60 fathoms.

Section XXVII extends from Vardø towards the NE as far as Novaja Semlja (lat. 74⁰ N). It shows the distribution of temperature throughout the eastern tract of the Barents Sea. All the isotherms incline towards Norway. From Vardø to the 36th degree of longitude, the temperature is above 0⁰ at the bottom. To the east, a temperature below 0⁰ occupies the deeper strata, and prevails off Novaja Semlja.

Section XXVIII, Pl. XIV, extends along the meridian of Greenwich, from 61⁰ (Shetland) to 78⁰ N. The surface-temperature decreases steadily towards the north, up to the 77th parallel of latitude. Between latitude 70⁰ and 73⁰ N, the water at the surface is somewhat colder than at a depth of 100 fathoms. The isotherm for 0⁰ reaches down at the 64th parallel of latitude to only 280 fathoms, but descends from thence towards the deep, till, between 70⁰ and 71⁰, it is met with at a depth of more than 600 fathoms, after which it rises towards the north, till, at 77⁰, it reaches the surface. An isolated patch, with a temperature a little above 0⁰, occurs at a depth of 100 fathoms, in lat. 77⁰—78⁰. The isotherm for — 1⁰, which at 63⁰—64⁰ lies somewhat deeper than 800 fathoms, sinks to 1000 fathoms at 65⁰—66⁰, rises to 870 fathoms at 68⁰, sinks to close upon 1000 fathoms a little to the north of 70⁰, rising up from thence towards the surface at the 74th parallel of latitude. From 74⁰ to 73⁰, it sends out a wedge southwards in the upper strata, and from 76⁰ to 77⁰ a similar one northwards. North of 76⁰, in greater depths, it forms a well-nigh closed curve round the maximum of heat, with a temperature above 0⁰. Between the 70th and 71st parallels of latitude occurs at the bottom a maximum

Tversnit XXIX, Pl. XIV, gaar langs Meridianen 10^0 E. f. Greenwich fra 64^0 (Fosen) til 80^0 (Spidsbergen) N. Br. Det overskjærer først de norske Kystbanker udenfor Helgeland, dernæst Vesteraalseggen, Lofotdybet, den østlige Del af Tverryggen og tilsidst Banken udenfor Spidsbergens Vestkyst. Paa Nordlandsbanken er Temperaturen meget jevn. Paa Vesteraalseggen komme Kuldegraderne højt op og trænge Varmegradsisothermerne sammen. Alle Isothermer sænke sig mod Dybet udenfor Eggen. Under 72^0 løfter Isothermen for -1^0 sig ivejret. I begge Dyb søndenfor og nordenfor Tverryggen komme minimale Temperaturer paa $-1^0.3$ og $-1^0.4$ tilsyne. Idet Snittet kommer ind paa Spidsbergbanken, viser det saavel den højere Temperatur ved dennes ydre Skraaning som den lave Temperatur, der udgaar fra Landet og breder sig derfra ud over Banken.

Tversnit XXX gaar langs Meridianen 10^0 W. f. Greenwich fra 60^0 til 75^0 N. Br. Det overskjærer Færø-Island-Ryggen, Jan Mayen Renden, Vestfoden af Jan Mayen og Grønlandshavet. Paa Island-Færø-Ryggen sees Overgangen fra den atlantiske til den nordiske Temperaturfordeling. Her ligge de varmeste Vandlag under Overfladen. I Jan Mayen-Renden sees det koldeste Vand at kaste sig over paa Sydsiden. Under Jan Mayen er det merkelig varmere paa Sydsiden end paa Nordsiden.

Tversnit XXXI, Pl. XIV, gaar fra Nordkysten af Island langs Meridianen $18^1/_2$ Grads vestlig Længde. Det og det følgende Snit er construeret efter de Danske Observationer med "Fylla" i 1878. Under Land er det varmest i Overfladen, men ved Bunden ligger Maximum af Varme ude paa Banken. Mod Nord findes den grønlandske Polarstrøms iskolde Vand fra Overfladen til Bunden.

Tversnit XXXII gaar fra Islands Nordkyst langs Meridianen $22^1/_2$ Grad W til Grønland. Maximum af Temperatur ligger under Island, saaledes at Overfladen har lavere Temperatur end Bunden. Ved denne ligge Isothermerne for 0^0 til 5^0 overordentlig tæt sammen. Den største Del af Danmarkstrædet er her fyldt af iskoldt Vand.

4. Temperaturens horizontale Fordeling.

For at vise Temperaturens Fordeling i horizontal Retning har jeg construeret Karterne Pl. XVI til XXV.

Paa Pl. XVI sees Havoverfladens aarlige Middeltemtemperatur fremstillet ved Hjelp af Isothermer for hver enkelt Grad Celsius.

Om Kartets Construction skal nedenfor gives nærmere Forklaring.

in which the temperature does not fall below $-1^0.17$. Between 66^0 and 69^0, the bottom-temperature is lower than $-1^0.3$. Between 73^0 and 76^0, the deeper strata, under 1000 fathoms, exhibit throughout a minimum-temperature of $-1^0.6$.

Section XXIX, Pl. XIV, extends along the meridian 10^0 east of Greenwich, from lat. 64^0 (Fosen) to lat. 80^0 (Spitzbergen) N. It passes first across the Norwegian coastal banks, off Helgeland, then across the Vesteraalseg, the Lofoten Deep, the eastern part of the Tranverse Ridge, and finally the bank off the west coast of Spitzbergen. On the Nordland Bank, the temperature is remarkably equable. On the Vesteraalseg, the frigid temperature rises highest, crowding together the isotherms for degrees above 0^0. All isotherms sink towards the deep off the edge of the bank. At 72^0, the isotherm for -1^0 curves upwards. In both Deeps, south and north of the Transverse Ridge, occur minimal-temperatures of $-1^0.3$ and $-1^0.4$. Where the section intersects the Spitzbergen Bank, it exhibits alike the higher temperature, on the outer slope, and the lower temperature, derived from the land, spreading from thence over the bank.

Section XXX extends along the meridian 10^0 west of Greenwich, from lat. 60^0 to 75^0 N. It crosses the Færoe-Iceland Ridge, the Jan-Mayen Channel, the western base of Jan Mayen, and the Greenland Sea. On the Iceland-Færoe Ridge is seen the transition from the Atlantic to the North Ocean distribution of temperature. Here, the warmest strata of water lies beneath the surface. In the Jan-Mayen Channel, the coldest water keeps to the south side. Off the coast of Jan Mayen, the water is appreciably warmer on the south than on the north side.

Section XXXI, Pl. XIV, extends from the north coast of Iceland along the meridian $18^1/_2{}^0$ W. This and the following section have been constructed from the observations taken on the Danish Expedition with the "Fylla," in 1878. Close inshore the highest temperature is found at the surface; but at the bottom the maximum occurs on the bank. Towards the north, the ice-cold water of the Greenland Polar current extends from the surface to the bottom.

Section XXXII passes from the north coast of Iceland, along the meridian $22^1/_2{}^0$ W, to Greenland. The highest temperature is found on the coast of Iceland; and the surface has here a lower temperature than the bottom. Along the latter, the isotherms for 0^0 to 5^0 lie very close together. The greater part of Denmark Strait is here filled with ice-cold water.

4. Horizontal Distribution of Temperature.

To show the distribution of thetemperature horizontally, I have constructed the maps in Pls. XVI to XXV.

Pl. XVI shows the mean temperature for the year, represented by means of isotherms for each degree Celsius.

The construction of the Map will be explained more fully further on.

Kartet over Havoverfladens aarlige Middeltemperatur (Pl. XVI) viser, at dennes Fordeling er afhængig, foruden af Bredden, i højeste Grad af Kysternes Retning. Paa mange Steder løbe Isothermerne nærmere langs Meridianerne end langs Parallelerne. Det characteristiske for Isothermernes Løb er deres Tungeform, og Tungernes Spidser pege paa forskjellige Steder i forskjellige Retninger. Den højeste Temperatur findes i Kartets sydvestlige Hjørne, hvor Isothermen for 11° optræder. Den laveste Temperatur findes i Grønlandshavet, hvor Isothermen for 0° løber parallel med dettes omtrentlige Grændse, og i den nordre Del af Østhavet mellem Spidsbergen og Novaja Semlja. I begge Have betegner Nulgrads-Isothermen den omtrentlige midlere Isgrændse. Isotherm-Tungernes concave Parti angiver ved sin Rækkefølge i Almindelighed den Egn, hvorfra Stedets Temperatur har sit Udspring, forsaavidt den er et Resultat af Strømninger. Man kan saaledes tale om varme og kolde Isotherm-Tunger. En Linie, der forbinder de successive Tungespidser, bliver en Varme-Axe eller en Kulde-Axe, der har den Egenskab, at i begge Retninger tvers paa Axen, saavel til Højre som til Venstre, er Temperaturen i Overfladen respective synkende eller stigende.

En Varme-Axe kan forfølges fra Atlanterhavet vestenfor Skotland, mod Færø-Island-Ryggen, langs denne mod Islands sydostlige Hjørne. Som dens Fortsættelse kunne vi betragte den langs Islands Vestkyst og Nordkyst gaaende Række af varme Tunger.

En anden Varme-Axe udgaar fra den forrige vestenfor Færøerne og tager Vejen nordenom disse Øer mod Øst ved den 63. Breddegrad, hvor den slutter sig til den næst følgende.

Denne udgaar fra samme Sted som den første, bøjer mod Øst nordenfor Orkenøerne, passerer Shetland og gaar herfra udenfor den norske Vestkyst. Udenfor Lofoten sender den en Arm mod Vest henimod Jan Mayen; under den 70. Breddegrad sender den en Arm nordover, der løber langs Spidsbergens Vestkyst helt op til den 80. Breddegrad, og en tredie Arm følger Norges Kyst østenfor Nordkap og den Murmanske Kyst til det Hvide Hav og Novaja Semlja.

En Varme-Axe sees ogsaa i Syd for Jan Mayen, gaaende mod Nordvest op paa Vestsiden af denne Ø.

En Kulde-Axe er antydet fra den nordlige Del af Østhavet henimod Spidsbergens Sydkap og Beeren-Eiland.

En anden fra Grønlandshavet mod Sydost omtrent midtvejs mellem Spidsbergen og Jan Mayen.

En tredie østenfor Jan Mayen.

En fjerde fra Grønlandshavet mellem Jan Mayen og Island, udenfor Islands Østkyst og videre mod Sydost til

The Map giving the Mean Annual Temperature of the Sea-Surface (Pl. XVI), shows the distribution to be dependent, not only on the latitude, but also, in the highest degree, on the direction of the coast. In many localities, the isotherms run closer along the meridians than they do along the parallels. The most prominent characteristic distinguishing the course taken by the isotherms, is their linguiform shape, and the tip of the tongue points in different places in different directions. The highest temperature is seen to occur in the south-western corner of the map, together with the isotherm for 11°. The lowest temperature occurs in the Greenland Sea, where the isotherm for 0° runs parallel to the approximate limit of the latter, and in the northern tract of the Barents Sea, between Spitzbergen and Novaja Semlja. In both seas, the isotherm for 0° marks the approximate mean limit of ice. The concave part of the linguiform isotherms generally points towards the tract from which the local temperature has its origin, provided it result from the action of currents. Hence, we can speak of warm and cold isothermal tongues. A line connecting the successive extremities of the linguiform parts, constitutes an axis of heat or of cold, with the property, that in both directions perpendicular to such an axis, alike to the right and to the left, the temperature at the surface is respectively falling or rising.

An axis of heat may be traced from the Atlantic, west of Scotland, to the Færoe-Iceland Ridge, and along the latter towards the south-eastern extremity of Iceland. As its continuation, we may regard the series of warm isothermal tongues extending along the west and north coasts of that island.

Another axis of heat strikes off from the preceding, west of the Færoes, and makes its way north of those islands towards the east, at the 63rd parallel of latitude, where it joins that next in succession.

This axis extends from the same point as the first, makes a bend to the east north of the Orkney Islands, and passes Shetland, proceeding thence towards the West Coast of Norway. Off Lofoten it sends off an arm westward, in the direction of Jan Mayen; at the 70th parallel of latitude it sends off an arm northward, which extends along the west coast of Spitzbergen, as far as the 80th parallel of latitude; and a third arm follows the coast of Norway, east of the North Cape, and the Murman coast, to the White Sea and Novaja Semlja.

An axis of heat also extends south of Jan Mayen, passing towards the north-west up along the west side of that island.

An axis of cold is found to proceed from the northern part of the Barents Sea towards South Cape, Spitzbergen, and Beeren Eiland.

Another extends from the Greenland Sea towards the south-east, about midway between Spitzbergen and Jan Mayen.

A third occurs east of Jan Mayen.

A fourth passes from the Greenland Sea between Jan Mayen and Iceland, off the east coast of the lat-

Farvandet i Nordost for Færøerne. Dens tilsyneladende Fortsættelse mod Syd i Øst for Færøerne betragter jeg tildels som en Virkning af de dybere kolde Lag paa Overfladens Temperatur. Temperaturen i Thorshavn er antagelig lavere end i Havet udenfor, paa Grund af Strømningerne i Sundene.[1]

En femte Kuldeaxe gaar langs Grønlands Østkyst i Danmarkstrædets vestlige Del, hvor Nulgradsisothermen bøjer sig hen imod Cap Farvel.

Pl. XVII viser Temperaturens Fordeling i 100 Favnes Dyb. Fra Atlanterhavet skyde varme Tunger op mod Nordhavet, vestenfor og nordenfor Island (7°, 6°, 5°, 4° og 3°), mellem Island og Færøerne (8°) og langs Banken udenfor Hebriderne (10°) og Shetland (9°). I den inderste Del af den norske Rende er Temperaturen 6°. Fra Nordsøbankens Spids ved Mundingen af den norske Rende skyde sig lange varme Tunger (8°, 7°, 6°, 5°) mod NNE udenfor Norges Vestkyst. Isothermerne for 6° og for 5° udskyde et Par Sidegrene mod Vest, den nordligste fra Lofoten henimod Jan Mayen. Paa Tungernes østre Side aftager Temperaturen henimod de norske Kystbanker, der saaledes ere omgjerdede af forholdsvis koldere Vand. Dette Fænomen optræder i fremtrædende Grad omkring Øerne i Vest-Lofoten, hvor Temperaturen i 100 Favnes Dyb kun er lidt over 4°.5. I det inderste dybe Bassin i Vestfjorden er der i dette Dyb 6° og derover. I Østhavet skyder en varm Tunge (4°) sig ind over den sydlige Del mellem Nordkap og Beeren-Eiland. Længere Øst deler Tungen sig i to Dele; den ene følger (3°, 2°, 1°) Finmarks- og Murman-Kysten, den anden vender sig mod Nordost. Lange, smale Varme-Tunger gaa (4°, 3°) udenfor Spidsbergens Vestkyst lige op til den 80. Breddegrad. Under denne Kyst er det merkelig koldere paa Banken. Vestenfor Is-Fjorden, Greenwich Meridian, sees en løsrevet Vandmasse med Varmegrader midt inde i Kuldegradernes Omraade.

I Østhavet skyde kolde Tunger sig ned mod den Murmanske Kyst og mod Spidsberg-Beeren-Eiland-Banken. Fra Grønlandshavet paa den 75. Breddegrad vestenfor Greenwich Meridian skyde kolde Tunger sig mod Sydost henimod Vesteraalen (70° N. Br. 12°.5 E. Lg.). En kold Tunge gaar sydover østenfor Jan Mayen, medens der paa Jan Mayen-Bankens Vestside findes en nordgaaende Tunge med varmere Vand. Mellem Jan Mayen og Island skyder en mægtig kold Tunge sig mod SSE og fortsætter, med Varmegrader, nordenom Færoerne, hvor den sender en Arm mod Øst og en anden Arm mod Syd, der optager

[1] Christiania Videnskabsselskabs Forhandlinger for 1873. Om visse Virkninger af Strømme paa Vandets og Luftens Temperatur.

ter, proceeding thence towards the south-east, as far as the tract of ocean lying north-east of the Færoe Islands. Its apparent continuation southwards, east of the Færoes, I attribute partly to the action of the deeper cold strata on the temperature of the surface. The temperature at Thorshavn is presumably lower than in the open sea round the Færoes, owing to the currents in the sounds.[1]

A fifth axis of cold extends along the east coast of Greenland, in the western part of Denmark Strait, where the isotherm for 0° curves towards Cape Farewell.

Pl. XVII shows the distribution of temperature at a depth of 100 fathoms. From the Atlantic, warm isothermal tongues shoot up towards the North Ocean, west and north of Iceland (7°, 6°, 5°, 4°, and 3°), between Iceland and the Færoes (8°), and along the bank lying off the Hebrides (10°) and the Shetlands (9°). Throughout the innermost part of the Norwegian Channel, the temperature averages 6°. From the extremity of the North-Sea Bank, at the mouth of the Norwegian Channel, long warm isothermal tongues (8°, 7°, 6°, 5°) extend towards the NNE, off the West Coast of Norway. The isotherms for 6° and 5° send off a couple of lateral arms towards the west, the most northerly from Lofoten in the direction of Jan Mayen. On the eastern side of the isothermal tongues, the temperature is found to diminish towards the Norwegian coastal banks, which accordingly are encompassed by relatively colder water. This phenomenon occurs in a very prominent degree round the islands of West Lofoten, where the temperature at a depth of 100 fathoms is but little more than 4°.5. In the deep innermost basin of the Vestfjord we have at this depth 6° and upwards. In the Barents Sea, a warm isothermal tongue (4°) extends through the southern tract, between the North Cape and Beeren Eiland. Farther east, this tongue divides into two parts, one (3°, 2°, 1°) following the Finmark and Murman coasts, the other passing north-east. Long, narrow tongues of heat (4° and 3°) extend along the west coast of Spitzbergen straight up to the 80th parallel of latitude. Off this coast the water is appreciably colder on the bank. West of Ice Sound, on the meridian of Greenwich, occurs an isolated patch exhibiting degrees above 0°, in the very region of the ice-cold water.

In the Barents Sea, cold isothermal tongues descend towards the Murman coast and the Spitzbergen-Beeren-Eiland Bank. From the Greenland Sea, on the 75th parallel of latitude, west of the meridian of Greenwich, cold isothermal tongues strike off south-east towards Vesteraalen (lat. 70° N, long. 12°.5 E). A cold isothermal tongue extends southward, east of Jan Mayen, whereas on the western side of the Jan-Mayen Bank we find a tongue of warmer water passing northward. Between Jan Mayen and Iceland, a most extensive cold isothermal tongue strikes off towards the south-south-east, passing on, with de-

[1] On certain Effects of Currents on the Temperature of the Sea and the Air. Journal of the Scottish Meteorological Society, Vol. IV., No. XL. Dec. 1873. p. 89.

Nordvestsiden af Færø-Shetland-Renden. I Danmark-Strædet gaar under Grønland en iskold Tunge mod Sydvest.

Pl. XVIII viser Temperaturens Fordeling i 200 Favnes Dyb. Langs Vestsiden af Island skyde varme Tunger sig mod Nord (6° og 5°), ligesaa op mod Islands Banker i Sydost for dette Land, paa Vestsiden af Færø-Banken og paa Nordvestsiden af Shetlandsbanken. Disse fortsætte, med aftagende Varmegrader, langs Norges Kystbanker, til hvilke de læne sig, uden at koldere Vand ligger imellem. Videre kunne de forfølges ind i den sydlige Del af Østhavet (2°) og langs Vestbanken udenfor Beeren-Eiland og Spidsbergen (2° ved 80° Bredde). Sidegrene udgaa mod Vest henimod Island, med et Varme-Maximum af 4°.3 (Station 52), og omkring 70° Bredde henimod Jan Mayen, samt under 78° Bredde fra Spidsbergen mod Vest.

De kolde Tunger findes i det Hele taget paa samme Plads som i 100 Favnes Dyb, fra det nordlige Østhav langs Østsiden af Beeren-Eiland-Banken, fra Grønlandshavet mod Sydost i Retning af Vesteraalen, østenfor Jan Mayen (varm Tunge vestenfor), gjennem Jan-Mayen-Renden, østenfor Island med Fortsættelse over den nordre Del af Island-Færø-Ryggen, nordenom Færø-Banken, østenfor samme paa Nordvestsiden af Færø-Shetland-Renden og mod den norske Kystbanke søndenfor 65° N. Br. I Danmark-Strædets nordvestre Del indtager iskoldt Vand det større Fladerum.

Paa 66° 35′ Bredde, 7° 50′ E. Længde gaar den norske Kystbanke i Retning W—E, medens den søndenfor og nordenfor gaar S—N. Vi finde her et Minimum af Temperatur ved Bunden (4°.8 og 4°.9, Stat. 121 og 122, i 192 og 201 Favnes Dyb); østenfor og vestenfor ere højere Temperaturer (6°.2, Stat. 120, 190 Fv.; 5°.6, Stat. 202 i 246 Fv.), ligesaa nordenfor i samme Dybde. Dette Minimum, der sees paa Kartet Pl. XVIII og paa Bundtemperatur-Kartet Pl. XXV, er en Straale af koldere Vand, der nordenfra trænger fra dybere Lag opover Banken. Forholdet anskueliggjøres ved det Verticalsnit langs Meridianen 8° E., der findes paa Pl. XXVI, hvor man ser Isothermerne for 5°, 6° og 7° løfte sig mod Syd henimod Bankens Eg.

Under 75°.5 N. Br. og 15° E. Længde stikker en Kile med Kuldegrader frem søndenfor Spidsbergens Sydkap. Det er den kolde Bundstraale, der ovenfor er omtalt og fremstillet i Tversnit i Profil XX, i

grees above 0°, north of the Færoe Islands, where it sends off an arm towards the east and another arm towards the south, the latter filling the north-west side of the Færoe-Shetland Channel. In Denmark Strait, an ice-cold isothermal tongue extends along the coast of Greenland, towards the south-west.

Pl. XVIII shows the distribution of temperature at a depth of 200 fathoms. Along the west coast of Iceland, warm isothermal tongues (6° and 5°) strike off towards the north, and likewise towards the Iceland banks lying south-east of that island, on the west side of the Færoe Bank, and on the north-west side of the Shetland Bank. These tongues continue their course, with diminishing temperature, along the Norway coastal banks, towards which they incline without having colder water between. They admit, too, of being traced farther, viz., into the southern part of the Barents Sea (2°), likewise along the western bank off Beeren Eiland, and off Spitzbergen (2°, lat. 80°). Lateral branches extend westward towards Iceland, with a maximum of heat, 4°.3 (Station 52), about the 70th parallel of latitude, towards Jan Mayen, and on the 78th parallel of latitude, from Spitzbergen towards the west.

The cold isothermal tongues have as a rule the same position as they are found to occupy at a depth of 100 fathoms, viz: from the northern tracts of the Barents Sea along the eastern side of the Beeren-Eiland Bank; from the Greenland Sea towards the south-east, in the direction of Vesteraalen; east of Jan Mayen (warm tongue westwards); through the Jan-Mayen Channel; east of Iceland, with continuation along the northern part of the Iceland-Færoe Ridge, north of the Færoe Bank, east of that bank on the north-west side of the Færoe-Shetland Channel, and towards the Norway coastal bank lying south of lat. 65° N. In the north-western part of Denmark Strait, ice-cold water occupies the greater area.

In lat. 66° 35′ N, long. 7° 50′ E, the Norway coastal bank extends W—E, whereas south and north it extends S—N. Here we have a minimum of temperature at the bottom (4°.8 and 4°.9, Stats. 121 and 122, at a depth of 192 and 201 fathoms); to the east and west occur higher temperatures (6°.2, Stat. 120, in 190 fms.; 5°.6, Stat. 202, in 246 fms.), also to the north at the same depth. This minimum, shown in the map, Pl. XVIII and in the Map of Bottom-Temperatures, Pl. XXV, has its origin in a stream of colder water that makes its way from the north and from the deeper strata up the slope of the bank. The relation will be seen by observing the vertical section that extends along the meridian 8° E, given Pl. XXVI, in which the isotherms for 5°, 6°, and 7° ascend towards the south, reaching nearly the edge of the bank.

In lat. 75°.5 N, long. 15° E, a wedge of ice-cold water pierces forward south of the southern extremity of Spitzbergen (South Cape). This is the cold bottom-stream mentioned above, and represented in the transverse section,

Længdesnit i Profil XXI, Pl. XII, og som sees i sin hele Udstrækning langs Bunden paa Pl. XXV.

Pl. XIX viser Temperaturens Fordeling i 300 Favnes Dyb. Vestenfor Island støder endnu 5⁰ til Banken. I Sydost for Island findes 7⁰ og paa Sydvestsiden of Wyville-Thomson-Ryggen 8⁰ til 9⁰. I Færø-Shetland-Rendens sydligste Del have vi et Temperatur-Maximum paa over 5⁰, omgivet paa Nord- og Sydsiden af koldere Vand. Langs Norges Kystbanker optræde lignende Maxima paa over 5⁰ udenfor Romsdalskysten (63⁰ N. Br.) og udenfor Røst (67⁰.5 N. Br.). Varme Tunger strække sig mod Vest mellem Lofoten og Jan Mayen og mod Nord langs Banken udenfor Vest-Spidsbergen (1⁰ ved 80⁰ N. Br.). Koldere Vand ved Banken sees under 7⁰—8⁰ E. Lgd., 66⁰.5 N. Br. og Vest for Beeren-Eiland, udenfor hvilket der er et Maximum paa 2⁰. Strax nordenfor dette sees den kolde Straale fra Spidsbergens Storfjord. Østhavets Bund ligger højere end 300 Favne.

De kolde Tunger fra Grønlandshavet gjenfindes. Nulgrads Tungen fra Jan Mayen-Renden udstrækker sit Omraade helt til den nordvestre Side af Færø-Shetland-Renden og henimod Nordsøbanken (62⁰.5 N. Br.) og de norske Kystbanker (3⁰—4⁰ E. Lgd.).

Under 69⁰ N. Br., udenfor Vesteraalen, ligger en Tunge med over 4⁰, der, som anført, fortsættes mod Vest. Isothermen for 3⁰ rækker, under 70⁰ N. Br., helt Vest til 1⁰ W. Lgd. Isothermen for 2⁰ udskyder, som Fortsættelse, en Tunge mod Syd, parallel med den iskolde Tunge i Jan Mayen-Renden. Vestsiden af Jan Mayen-Banken har endnu Varmegrader.

Pl. XX viser Temperaturens Fordeling i 400 Favnes Dyb. Nordhavet er i dette Dyb ganske adskilt fra Atlanterhavet. I dette sidste findes 7⁰—8⁰ opunder Islandsbanken og Wyville-Thomson-Ryggen. Paa den anden Side af denne sees i Midten af Færø-Shetland-Renden en liden Tunge med Varmegrader, ellers er hele Renden og Havet nordenfor til c. 61⁰ N. Br. fyldt med iskoldt Vand. Enkelte Steder optræder under Banken endog — 1⁰.

Det er, i dette Dyb, paa højere Bredder, at man har Varmegradernes Region. Fra et Maximum paa over 3⁰, der ligger klos udenfor Vesteraalen, skyde sig Varmetunger med Vest og mod Nord. De første bøje østenfor Jan Mayen mod Syd og, som det synes, mod Sydost, culminerende i et Maximum paa 1⁰.6 i Station 96. Lidt længere Nord have vi en Tunge mod Syd i Retning af det Parti, hvor Banken løber tvers paa Meridianen (Snit 8⁰ E. Pl. XXVI). Fra Vesteraalen af forfølge vi Varmetunger nordover udenfor Beeren-Eilands og Vestspidsbergens Banker, med koldere Vand inde ved Banken, lige til 0⁰ ved 80⁰ Bredde. Strax Nord for 75⁰ N. Br. spores den iskolde Tunge fra Storfjorden. De kolde Tunger fra Grønlands-

profile XX, in the longitudinal section profile XXI, Pl. XII, and seen throughout its whole extent along the bottom Pl. XXV.

Pl. XIX shows the distribution of temperature at a depth of 300 fms. West of Iceland, 5⁰ is still found close to the bank. South-east of Iceland, we have 7⁰, and on the south-west side of the Wyville-Thomson Ridge 8⁰—9⁰. In the most southerly part of the Færoe-Shetland Channel, there is a temperature-maximum of more than 5⁰, surrounded on the north and south by colder water. Along the Norwegian coastal banks occur similar maxima, reaching more than 5⁰, viz., off the Romsdal coast (lat. 63⁰ N) and off Røst (lat. 67⁰.5 N). Warm isothermal tongues extend westward between Lofoten and Jan Mayen, and northward along the bank off West Spitzbergen (1⁰ in lat. 80⁰ N). Colder water is met with on the bank in long 7⁰ to 8⁰ E, lat. 66⁰.5 N, and west of Beeren Eiland, off which occurs a maximum of 2⁰. Immediately to the north of this maximum, flows the cold stream from Spitzbergen's Storfjord. The bottom of the Barents Sea lies higher than 300 fathoms.

The cold isothermal tongues sent off from the Greenland Sea are again met with. The zero-tongue from the Jan-Mayen Channel extends its limits to the north-western side of the Færoe-Shetland Channel, and almost as far as the North-Sea Bank (lat. 62⁰.5 N) and the Norway coastal banks (long. 3⁰—4⁰ E).

In lat. 69⁰ N, off Vesteraalen, lies an isothermal tongue, with upwards of 4⁰ of heat, which, as previously stated, extends farther towards the west. The isotherm for 3⁰ reaches, in lat. 70⁰, as far as long. 1⁰ W. The isotherm for 2⁰ sends off, in continuation, a tongue southward, parallel to the ice-cold tongue in the Jan-Mayen Channel. The western slope of the Jan-Mayen Bank still exhibits a temperature above 0⁰.

Pl. XX shows the distribution of temperature at a depth of 400 fathoms. At this depth, the North Ocean is entirely cut off from the Atlantic. The latter has 7⁰—8⁰ in close proximity to the Iceland Bank and the Wyville-Thomson Ridge. On the opposite side of the latter, a small isothermal tongue, with a temperature a little above 0⁰ occurs in the middle of the Færoe-Shetland Channel, but with this exception the whole channel and the sea without to well-nigh lat. 61⁰ N, is filled with ice-cold water. In a few places, we have off the bank even — 1⁰.

It is throughout this deep, in higher latitudes, that the region with temperatures above 0⁰ is met with. From a maximum of more than 3⁰, lying close off Vesteraalen, the isothermal tongues of heat strike out west and north. The former bend off east of Jan Mayen towards the south, and also, it would seem, towards the south-east, culminating in a maximum of 1⁰.6, at Station 96. Somewhat farther north, there is a tongue stretching southward, in the direction of the tract where the bank extends perpendicular to the meridian (Section 8⁰ E, Pl. XXVI). From Vesteraalen, we can trace isothermal tongues of heat northwards, off the Beeren-Eiland and the West-Spitzbergen Banks, with colder water in immediate proximity

havet gjenfindes paa sine Steder paa de tidligere Karter. Isothermen for 0^0 omspænder i den sydlige Del af det norske Hav et betydeligt større Omraade end i de højere Niveauer.

Pl. XXI viser Temperaturens Fordeling i 500 Favnes Dyb. I Atlanterhavet er Varmegrader, $2^0.9$ under Islandsbanken, $8^0.1$ under Wyville-Thomson-Ryggen. I det norske Hav ere Varmegraderne indskrænkede til Partiet omkring den 70. Breddegrad mellem Jan Mayen og Vesteraalen, hvor et Par Maxima paa 2^0 optræde, det ene under Land, det andet længere mod Vest, og hvorfra der udgaar mod Nord en lang smal Tunge til Spidsbergen. Indenfor denne Tunge, nærmere Banken, er der Kuldegrader. Mod Vest følger Isothermen for — 1^0 langs den for 0^0 fra Nordvest-Spidsbergen til Jan-Mayen-Banken. Paa dennes Vestside bøjer den ind som en Varme-Tunge, og fortsætter som en Kulde-Tunge langs Islands-Banken. I Færø-Shetland-Renden er det koldest i Midten, under — 1^0. Lignende lav Temperatur træffes langs Norges Banker fra 63^0 til 68^0 Bredde, medens Temperaturen er højere midt i Havet.

Pl. XXII viser Temperaturens Fordeling i 600 Favnes Dyb. I Atlanterhavet er fremdeles Varmegrader, over 6^0 i Sydvest for Færøerne. I det norske Hav ere Varmegraderne indskrænkede til et enkelt Parti omkring den 71. Breddegrad, der omcirkles af Isothermen for 0^0, og som støder nærmest til Land udenfor Vesteraalen. Isothermerne for — $0^0.5$ og — 1^0 danne Tunger udenfor Beeren-Eiland og Spidsbergen, med koldere Vand langs Banken. Isothermen for — 1^0 har forøvrigt meget nær samme Løb som i 500 Favne. Den løber langs Banken fra Færø-Shetland-Renden til Vesteraalen og har her varmere Vand vestenfor sig.

Varmegraderne naa i Nordhavet ikke ned til 700 Favnes Dyb. I de følgende 3 Karter, der vise Temperaturens Fordeling i 1000 og i 1500 Favne samt ved Bunden, har jeg, forat tydeliggjøre denne, optrukket Isothermerne for — 1^0 og for hver Tiendedels Grad under — 1^0. Herved er der, ligesom i Vertical-Snittene, taget Hensyn til de i Tabellen Side 44—61 opførte Hundredele af Grader. Som ovenfor Side 39 anført, kunne Bundtemperaturerne ansees sikkre paa mindre end $\pm 0^0.05$.

Pl. XXIII viser Temperaturens Fordeling i 1000 Favnes Dyb. I den sydligste Del af det norske Hav er et Maximum, der omcirkles af Isothermen for — 1^0, med lavere Temperatur paa alle Sider. Et lignende Maximum ligger ved den 70. til 71. Breddegrad i Lofotdybet. Begge Maxima omsluttes af Isothermen for — $1^0.1$. Isothermen

to the bank, as far down as 0^0 on the 80th parallel of latitude. Immediately to the north of lat. 75^0 N, the ice-cold tongue from the Storfjord asserts its influence. The cold isothermal tongues from the Greenland Sea are again met with in their former places on the previous maps. The isotherm for 0^0 encloses in the southern part of the Norwegian Sea a much more extensive space than at higher levels.

Pl. XXI shows the distribution of temperature at a depth of 500 fathoms. In the Atlantic, the temperature is above 0^0, reaching $2^0.9$ at the Iceland Bank and $8^0.1$ at the Wyville-Thomson Ridge. In the Norwegian Sea, the temperature above 0^0 is confined to the tract about the 70th parallel of latitude, between Jan Mayen and Vesteraalen, where a couple of maxima of 2^0 are found to occur, one near the coast, the other farther west, and whence a long, narrow isothermal tongue stretches north to Spitzbergen. On the inner side of this tongue, at the bank occurs a temperature below 0^0. Towards the west, the isotherm for — 1^0 runs parallel to that for 0^0, from the north-west of Spitzbergen to the Jan-Mayen Bank. On the western slope of the latter, it bends up as a tongue of of heat, and passes farther on as a tongue of cold along the Iceland Bank. In the Færoe-Shetland Channel, it is coldest in the middle part, viz., below — 1^0. A similar low temperature is met with along the Norwegian banks, from lat. 63^0 to 68^0 N, whereas the temperature is higher in the central part of the sea.

Pl. XXII shows the distribution of temperature at a depth of 600 fathoms. In the Atlantic, temperatures above 0^0, more than 6^0, south-west of the Færoes, continue to occur. In the Norwegian Sea, we have water above 0^0 confined to a single tract, extending round the 71st parallel of latitude, which is enclosed by the isotherm for 0^0, and approaches land nearest Vesteraalen. The isotherms for — $0^0.5$ and — 1^0 form tongues off Beeren Eiland and Spitzbergen, with colder water along the banks. The isotherm for — 1^0 takes, for the rest, much the same course as in 500 fathoms. It extends along the bank from the Færoe-Shetland Channel to Vesteraalen, and has here warmer water on the western side.

A temperature above 0^0 in the North Ocean does not reach down to a depth of 700 fathoms. In the following 3 maps, showing the distribution of temperature at depths of 1000, 1500 fathoms, and at the bottom, I have drawn the isotherms for — 1^0 and for every tenth of a degree under — 1^0. When so doing, regard was taken, as with the vertical sections, to the hundredths of degrees given in the Table p. p. 44—61. As stated above, p. 39, the bottom-temperatures may be considered trustworthy within $\pm 0^0.05$.

Pl. XXIII shows the distribution of temperature at a depth of 1000 fathoms. In the most southern part of the Norwegian Sea, we have a maximum of temperature shut in by the isotherm for —1^0, on all sides with a lower temperature. A similar maximum occurs, from the 70th to the 71st parallel of latitude, in the Lofoten Deep.

for — 1°.2 danner en lang Varme-Tunge mod Nord udenfor Beeren-Eiland- og Spidsberg-Banken, med koldere Vand inde ved Banken. Nær parallel med den løbe Isothermerne for — 1°.3, — 1°.4 og — 1°.5. Den laveste Temperatur, — 1°.6, findes indenfor den sidste i Grønlandshavet nordenfor Jan Mayen. Paa den sydvestlige Rand af Jan-Mayen-Banken er et lidet Temperaturmaximum paa — 1°. Paa den søndre Side af Jan Mayen-Renden gaa kolde Tunger mod Sydost.

Pl. XXIV viser Temperaturens Fordeling i 1500 Favnes Dyb. Her have vi to adskilte Bassiner. I det sydlige er et Temperatur-Maximum paa — 1°.1 omgivet af koldere Vand ved Bankerne, indtil — 1°.3. Paa Jan Mayens Bredde ligger et andet Maximum paa over — 1°.2, og udenfor Vesteraalen et lignende af meget mindre Omfang. I Indbugtningerne i Banken i Lofot-Dybet ligge Minima paa — 1°.3 mod Nord, mod Øst og mod Syd.

I det nordre Bassin optræder — 1°.5 mod Øst og — 1°.6 mod Vest. Det koldeste Parti er det sydvestre Hjørne. Bundens Form nordenfor dette kjendes ikke.

Both maxima are encompassed by the isotherm for — 1°.1. The isotherm for — 1°.2 constitutes a long tongue of heat, extending north off the Beeren-Eiland and the Spitzbergen Bank, with colder water in its immediate proximity. Well-nigh parallel to it run the isotherms for — 1°.3, — 1°.4, and — 1°.5. The lowest temperature, — 1°.6, occurs westward of the last in the Greenland Sea, north of Jan Mayen. On the southwestern margin of the Jan-Mayen Bank, there is alimited temperature-maximum of — 1°. On the south side of the Jan-Mayen Channel, cold isothermal tongues extend towards the south-east.

Pl. XXIV shows the distribution of temperature at a depth of 1500 fathoms. Here we have two separate basins. In the southern, there is a temperature-maximum of — 1°.1, surrounded at the banks by colder water reaching — 1°.3. On the latitude of Jan Mayen occurs another maximum of more than — 1°.2; and off Vesteraalen we have a third, of very limited extent. In the indentations of the bank in the Lofoten Deep, there are minima reaching — 1°.3 towards the north, towards the east, and towards the south.

In the northern basin, occurs a temperature of — 1°.5 towards the east, and of — 1°.6 towards the west. The coldest part is the south-western corner. The contour of the sea-bed towards the north has not yet been determined.

5. Temperaturens Fordeling ved Havbunden.

Pl. XXV viser Temperaturens Fordeling ved Havbunden. Man ser, at den største Del af Havbunden i vort Nordhav er dækket af iskoldt Vand, hvis Temperatur er under — 1°. Forfølger man Linien for 0°, ser man, at den overalt, undtagen i Østhavet, ligger nær den for — 1°. I Atlanterhavet er der Varmegrader ved Bunden, i vort Nordhav findes disse kun paa Kystbankerne og i den vestlige Del af Østhavet. Men de strække sig mod Nord lige op til den 80. Breddegrad paa Havets østre Side, ved Spidsbergen. Vand med Varmegrader dækker Islands Kystbanker rundt om hele Øen, Island-Færø-Ryggen, Færø-Bankerne, Wyville-Thomson-Ryggen, hele Nordsøens Flak, de norske Kystbanker, den vestlige og sydlige Del af Østhavet, Vestspidsbergens Banker og en liden Del af Jan Mayen-Banken. Grændselinien 0° følger saaledes i det Store Bankernes Omrids. Disse holde, saa at sige, det iskolde Vand langt borte fra Islands Kyster, fra Færøernes Kyster, fra de skotske Øer, og fra Norges Kyster og Fjorde og, om end i ringere Grad, fra Beeren-Eilands og Spidsbergens Vestkyst. Hvor Bankens Eg nærmer sig Land, nærmer ogsaa det iskolde Vand sig samme, som nordenfor Færøerne, ved Storeggen, ved Vesteraalen, hvor Afstanden fra Land ved Andenes kun er 20 Kvartmil, og ved Spidsbergen. Men overalt ligger, som Verticalsnittene vise, Nul Grad paa Bankens ydre Skraaning, intetsteds stige Kuldegraderne over Eggen ind paa Banken. Det er saaledes virkelig Banken, der ved sin Form og Udstrækning holder

5. Distribution of Temperature at the Sea-Bottom.

Pl. XXV shows the distribution of temperature at the bottom. The greater part of the bed throughout the North Ocean is covered with ice-cold water, having a temperature below — 1°. If we follow the isothermal line for 0°, we shall everywhere find it, save in the Barents Sea, near that for — 1°. In the Atlantic, degrees above 0° occur at the bottom; in the North Ocean, on the coastal banks only; and in the Barents Sea, throughout the western part. But towards the north, they extend up to the 80th parallel of latitude, on the east side of the sea, off Spitzbergen. Water with a temperature above 0° covers the Iceland coastal banks, all round the island, likewise the Iceland-Færoe Ridge, the Færoe Banks, the Wyville-Thomson Ridge, the whole of the North-Sea Flat, the Norway coastal banks, the western and southern tracts of the Barents Sea, the West Spitzbergen Banks, and a small portion of the Jan-Mayen Bank. The boundary line for 0° follows, therefore, speaking generally, the contour of the banks. These keep, it may be said, the ice-cold water far away from the coasts of Iceland, from those of the Færoes, from the Scottish isles, from the coasts and fjords of Norway, and also, though in a less degree, from the western shores of Beeren Eiland and Spitzbergen. Where the edge of the banks approaches land, the ice-cold water does so too, as, for exemple, north of the Færoes, off the Storeg, off Vesteraalen (here the distance from land — off Andenes — is only 20 nautical miles), and off Spitzbergen. But 0°

Havdybets Kuldegrader i Afstand fra Landet. Det er kun ved Grønland og i Grøndlandshavet, at Kuldegraderne stige op til Overfladen, ellers indtages de af de dybere Partier.

Et opmerksomt Studium af Temperaturens Fordeling paa Havbunden imellem Nulgradslinien og Kysten, eller det varme Vands Fordeling paa Kystbankerne viser, at Temperaturen i Regelen ikke aftager stadig fra Kysten (Overfladen) til Nulgradslinien, men at Forholdet er det, at den først er noget lavere under Land, i de ringere Dybder, derpaa i større Afstand fra Land, længere ude paa Banken, er højere og naar, i samme Tversnit, et Maximum, og fra dette af synker den stadig mod 0° med stigende Afstand fra Kysten. Forholdet finder paa Kartet sit grafiske Udtryk i Isothermernes Tungeform. Vi iagttage det søndenfor, vestenfor og nordenfor Island, mellem Shetland og Norge, paa de norske Kystbanker og paa Vestspidsbergens Banker. Søndenfor og tildels vestenfor Island ligger en Maximumzone paa 7° og 6°. Isothermen for 5° strækker sin Tunge rundt Islands nordvestre Hjørne og videre østover til 20° W. Lgd. Paa Vestsiden af Færø-Island-Ryggen gaar en Tunge med 4° op mod Island. Færøerne omsluttes af Isothermen for 8°, medens Temperaturen i Thorshavn ikke er højere end 7°.9. I Nordost for Shetland ligge Isothermerne for 9°, 8° og 7° med sine Tungespidser mod Nordost. Isothermen for 5° omslutter det indre Parti af den norske Rende fra Udsire til inderst i Skagerak. Udenom den ligger Isothermen for 6° med en Tunge mod Nord udenfor Norges Vestkyst. Videre mod Nord se vi Isothermen for 7° med sin Tungespids lidt Nord for den 65. Breddegrad, medens den berører Land allerede paa 63°.5. Isothermen for 6° sender en Arm ind til det Inderste af Vestfjorden, hvor Temperaturen i den derværende Fordybning, der naar ned til over 340 Favne (Station 255), er over 6°, og en anden smal Arm udenfor Lofoten og Vesteraalen indtil Andenes (69° N. Br.), medens den berører Land ved 66° N. Br. Omkring Lofoten ligger et Belte med en Temperatur af under 5°. Isothermen for 5° rækker paa Banken op til 71° N. Br., men findes ved Kysten saa langt nede som ved Andenes (69°). I Østhavet aftager Temperaturen stadig fra Kysten af mod Nord og mod Øst. I Syd for Spidsbergens Sydkap trænger en iskold Arm frem fra Storfjorden mod Sydvest, uden dog, som det synes, at naa frem til Ishavsdybets iskolde Vand. (Se Side 68). Udenfor Spidsbergens Vestkyst omslutter Isothermen for 2° et Par Varmemaxima ledsaget af Isothermerne for 1° og 0°. Under Land er Vandet iskoldt, ude paa Banken er det varmere. Paa Jan Mayen-Banken sees et lidet Parti med Vand over 0°.

lies everywhere, as shown by the vertical sections, on the outer slope of the bank; degrees below 0° are nowhere found to rise over the edge and extend above the bank. Hence it is virtually the bank which, by reason of its form and extent, keeps the cold of the deep at a distance from land. Off Greenland only, and in the Greenland Sea, do degrees below 0° rise up to the surface; elsewhere they occupy exclusively the deeper strata.

A careful study of the distribution of temperature on the sea-bed between the isotherm for 0° and the coast, or of the distribution of the warm water on the coastal banks, will show that the temperature does not as a rule diminish gradually from the coast (the surface) to the isotherm for 0°, but at first is somewhat lower, in the lesser depths, close to land, whereupon it rises at some distance from the shore, farther out on the bank, reaching, in the same transverse section, a maximum, from whence it sinks gradually down to 0°, with the distance increasing from the coast. This relation is shown diagrammatically on the map, with the linguiform isothermal characteristic. We observe it to the south, west, and north of Iceland, between Shetland and Norway, on the Norwegian coastal banks and those of West Spitzbergen. South, and partly west, of Iceland lies a maximum-zone, with 7° and 6°. The isotherm for 5° sends off a tongue round the north-western extremity of Iceland, continuing eastward, to long. 20° W. On the west side of the Færoe-Iceland Ridge, an isothermal tongue, with 4°, extends up towards Iceland. The Færoes are encompassed by the isotherm for 8°, whereas the temperature in Thorshavn does not reach higher than 7°.9. North-east of Shetland we have the isotherms for 9°, 8°, and 7°, with their tongues stretching north-east. The isotherm for 5° encloses the inner part of the Norwegian Channel, from Udsire to the eastern limits of the Skagerak. Encircling this line, extends the isotherm for 6°, with a tongue stretching northwards, off the West Coast of Norway. Still farther north we have the isotherm for 7°, with its tongue reaching a little to the north of the 65th parallel of latitude, while it touches land in lat. 63°.5 N. The isotherm for 6° sends off an arm to the innermost part of the Vestfjord, where the temperature in the depression occurring there, which reaches down to more than 340 fathoms (Stat. 255), is over 6°, and another narrow arm, off Lofoten and Vesteraalen, to Andenes (lat. 69° N), whereas it touches land in lat. 66° N. Round Lofoten extends a belt with a temperature below 5°. The isotherm for 5° reaches on the bank up to lat. 71° N, but off the coast is met with as far south as Andenes (lat. 69° N). In the Barents Sea, the temperature gradually diminishes from the coast towards the north and the east. South of the southern extremity of Spitzbergen (South Cape), an ice-cold arm strikes off from the Storfjord towards the south-west, without however apparently reaching the ice-cold water of the Arctic Deep (See p. 68). Off the west coast of Spitzbergen, the isotherm for 2° encompasses a couple of temperature-maxima, accompanied by the isotherms for 1° and 0°. In immediate proximity to land

Saavel i Overfladen som langs Havbunden viser saaledes Temperaturen sig lavere under Land end i større Afstand fra Kysten. Der udgaar aabenbart fra Landet en afkjølende Virkning. Jeg benævner dens Aarsag: Landkulden, og skal nedenfor gjøre Rede for dens Oprindelse og Virkning.

Isothermerne for — 1⁰ til 5⁰ ligge i det Hele taget meget tæt paa Kartet, hvad der har sin Grund dels i, at Temperaturen varierer sterkt paa en kort Strækning, dels i Bundens sterke Skraaning. I det store Dyb, der indtages af Kuldegrader under — 1⁰, er Temperaturens Fordeling meget mere jevn og lader sig ikke fremstille, uden at man tager Tiendedelsgrader i Betragtning.

I Færø-Shetland-Renden gaar Temperaturen ned under — 1⁰.1 langs Rendens Bund. Mellem Island og Norge findes i Norske-Dybet et Temperatur-Maximum paa — 1⁰.17 (Station 52) omgivet af koldere Vand. Et endnu mere udpræget Maximum findes mellem Jan Mayen og Norge, med Temperaturer over — 1⁰.2, omgivet paa alle Sider af lavere Temperaturer. Den laveste Bundtemperatur findes i Grønlandshavet. Den gaar ned til — 1⁰.6 til — 1⁰.7 og naar saaledes ikke Havvandets Frysepunkt under almindeligt Tryk (c. — 2⁰.0). Fra Grønlandshavet mod Spidsbergen og Beeren-Eiland er Temperaturen stadig stigende til 0⁰. Fra den sydlige Del af dette Parti (72⁰.5 N. Br.) skyder sig (mellem 10⁰ og 15⁰ E. Lgd.) langs Bunden en bugtet Arm med koldere Vand, — 1⁰.4 og — 1.⁰3, sydover mellem det ovennævnte Maximum paa 71⁰ N. Br. og de norske Banker ned i Lofot-Dybet, hvor Isothermen for — 1⁰.3 omslutter et større Omraade og naar ned til 65⁰.5 N. Br. (Snit No. XIII, Pl. XI). Gjennem Jan Mayen-Renden skyde sig fra Grønlandshavet kolde Tunger med Temperaturer paa — 1⁰.5, — 1⁰.4 og — 1⁰.3 mod Øst henimod Norge, men uden, som det synes, ganske at naa det sidst oven nævnte kolde Parti i Lofotdybet.

I det søndre Bassin — Norske-Dybet — er Temperaturen gjennemsnitlig højere end i det nordre Bassin — Svenske-Dybet.

Tversnit og Karter vise saaledes en ejendommelig Fordeling af Temperaturen i Nordhavet. Medens i Atlanterhavet, ligesom i Nordhavet, Temperaturen saagodtsom overalt aftager fra Overfladen mod Dybet, finde vi i det første endnu Varmegrader ved Bunden, medens vi i det sidste finde det dybere og større Parti indtaget af Vand med Kuldegrader. Grændsen mellem begge Have, der saa bestemt angives ved de undersøiske Rygge, der danne en uafbrudt Forbindelse mellem Skotland og Grønland over Færoerne og Island, skiller ogsaa mellem Atlanterhavets varme Vand i Dybet og Nordhavets iskolde. Det iskolde Vand rækker i Færø-Shetland-Renden netop op til, paa et enkelt Sted kanske lidt over, Wyville Thomson-Ryggens Kam. Island-Færø-Ryggen ligger højere. I Danmarkstrædet ræk-

the water is ice-cold, out on the bank warmer. On the Jan-Mayen Bank occurs a limited tract with water above 0⁰.

Both at the surface and along the sea-bed, the temperature is accordingly found to be lower in close proximity to land than at some distance from the coast. It is obvious that a cooling influence issues from the land. The cause of this I designate: the *land-cold*, and in the sequel I shall explain its origin and effects.

The isotherms for — 1⁰ to 5⁰ generally lie very close together on the map, which arises partly from the temperature exhibiting considerable variation over a limited area, partly from the rapid decline of the bottom. In the great deep, that has a temperature under — 1⁰, the distribution of temperature is much more equable, and does not admit of being represented without having recourse to tenths of a degree. In the Færoe-Shetland Channel, the temperature falls below — 1⁰.1 along the bottom. Between Iceland and Norway, we have in the Norway Deep a temperature-maximum of — 1⁰.17 (Station 52), surrounded by colder water. A maximum more prominent still occurs between Jan Mayen and Norway, with a temperature over — 1⁰.2, enclosed on all sides by a lower. The lowest bottom-temperature is met with in the Greenland Sea. It reaches down to — 1⁰.6 or — 1⁰.7, and does not therefore attain the freezing-point for sea-water under ordinary pressure (about — 2⁰.0). From the Greenland Sea towards Spitzbergen and Beeren Eiland, the temperature rises steadily up to 0⁰. From the southern part of this tract (lat. 72⁰.5 N), a sinuous arm, with colder water, — 1⁰.4 and — 1⁰.3, strikes off (between long. 10⁰ and 15⁰ E) along the bottom, passing southward between the aforesaid maximum in lat. 71⁰ N and the Norway Banks down into the Lofoten Deep. The isotherm for — 1⁰.3 encompasses a considerable area, reaching as far south as lat. 65⁰.5 N (Section XIII, Pl. XI). Through the Jan-Mayen Channel, cold isothermal tongues, with temperatures — 1⁰.5, — 1⁰.4, and — 1⁰.3, extend eastward from the Greenland Sea towards Norway, yet without, it would seem, quite reaching the last-mentioned cold tract in the Lofoten Deep.

In the southern basin — the Norway Deep — the temperature is higher on an average than in the northern basin — the Swedish Deep.

Hence, the vertical sections and the maps show a peculiar distribution of temperature in the North Ocean. While the temperature, alike in the Atlantic and the North Ocean, almost everywhere diminishes from the surface to the deep, a temperature above 0⁰ is still found to occur in the former at the bottom, whereas in the latter the deeper and more extensive tract is filled with water having a temperature below 0⁰. The boundary between the two seas, so prominently determined by the submarine ridges that constitute an uninterrupted line of connexion between Scotland and Greenland past the Færoes and Iceland, likewise serves to separate the warm water in the depths of the Atlantic from the ice-cold water of the North Ocean. The ice-cold water reaches in the Færoe-Shetland Channel just up to

ker det iskolde Vand ved Bunden til Tærskelen mellem Grønland og Island; søndenfor er Varmegrader ved Bunden. Det er til et Niveau af c. 300 Favnes Dyb, at det iskolde Vand rækker op ved Grændsen mod Atlanterhavet.

Den isotherme Flade for 0° ligger i Nordhavet paa temmelig forskjellig Dybde paa de forskjellige Steder. I Grønlandshavet og i Østhavet er der Kuldegrader allerede i Overfladen. Deres Øst- og Syd-Grændse angives ved Isothermen for 0° paa Kartet Pl. XVI. Østenfor og søndenfor denne Linie ligger det varme Vand i de øvre Lag. Dets horizontale Begrændsning sees paa Kartet Pl. XXV, dets verticale paa Snittene Pl. IX til XV. I den søndre Del af vort Nordhav række, i de øvre Lag, Varmegrader over hele Strækningen fra Danmarkstrædet til Norge. Jo længere man kommer nordover, desto mere indsnevres Bredden af det varme Vandlag. Allerede noget nordenfor Jan Mayen er den vestre halve Bredde iskold, og kun den østre har Varmegrader. Fra 74° Bredde er Bredden betydelig indskrænket og bliver stadig mindre, indtil det varme Vand ophører ved Nordvestspidsbergen. I Østhavet holder derimod Bredden sig temmelig jevn og stor.

Den Dybde, til hvilken Varmegraderne naa, er i Almindelighed noget større ude i Havet end inde ved Banken, og i end højere Grad er dette Tilfældet med Isothermen for — 1°. Den sænker sig i det søndre Bassin dybt ned mod dets Midte, i det nordre ligger dens Indsænkning henimod den østre Skraaning. For tydeligere at vise dette Forhold har jeg paa Kartet Pl. XXIX afsat en bred skygget Linie, der gaar gjennem de dybeste Punkter af Isothermerne for — 1°. Paa Pl. XXVI er afsat Isothermernes verticale Fordeling, projiceret paa en Meridian langs den østlige Rand af Nordhavet. Mellem Spidsbergen og Nordkap er sat et Grændsesnit over Beeren-Eiland, og fra Stad til Shetland et lignende, i hvilke Isothermerne ere optegnede i Verticalsnit. Ellers ere kun Bundtemperaturerne paa Bankernes Skraaninger benyttede, og Linierne indpassede efter Verticalsnittene og Isothermkarterne for de forskjellige Dybder. Man vil gjenkjende Virkningen af Landkulden i de øvre Lag. Søndenfor Vesteraalen (69° N. Br.) ligge Isothermerne 0° til 5° meget tæt sammen. Den følgende Tabel, hvis Tal ere tagne efter Profilet, viser Isothermernes Dybde ved Banken og deres Maximums-Dybde ude i Havet for 0° og for — 1° for de forskjellige Breddegrader.

— in a single locality perhaps a little over — the crest of the Wyville-Thomson Ridge. The Iceland-Færoe Ridge lies higher. In Denmark Strait, the ice-cold water at the bottom reaches, so to speak, the threshold between Greenland and Iceland; farther south, water above 0° occurs at the bottom. It is to a level of close upon 300 fathoms from the surface, that the ice-cold water rises up at the boundary towards the Atlantic.

The isothermal surface for 0° lies in the North Ocean at very different depths in the various localities. In the Greenland Sea and the Barents Sea water below 0° occurs at the surface even. The limit to the east and south is indicated by the isotherm for 0° in the maps, Pl. XVI. To the east and south of this line, the warm water occurs in the upper strata. Its horizontal limit is shown in the map, Pl. XXV, its vertical in the sections, Pls. IX to XV. In the south part of the North Ocean, temperatures above 0° extend over the upper strata throughout the whole tract, from Denmark Strait to Norway. The farther north you go, the less becomes the breadth of the warm water. Even a little to the north of Jan Mayen, half the breadth — the western — consists of ice-cold water, the eastern only exhibiting degrees above 0°. From lat. 74° N, the breadth becomes considerably diminished, and steadily lessens, till, off the north-west coast of Spitzbergen, the warm water altogether disappears. In the Barents Sea, on the other hand, the breadth keeps comparatively equal and considerable.

The depth down to which a temperature above 0° is found to reach, is generally somewhat greater out at sea than close to the bank; and this refers in a still higher degree to the isotherm for — 1°. It sinks in the southern basin to a great depth towards the middle; in the northern, its lowest point lies towards the eastern declivity. In order to illustrate this relation with greater distinctness, I have drawn on the map, Pl. XXIX, a broad, shaded line passing through the deepest points of the isotherms for — 1°. Pl. XXVI shows the vertical disposition of the isotherms — projected on a meridian — along the eastern margin of the North Ocean. Between Spitzbergen and the North Cape, I have traced a boundary-section, passing over Beeren-Eiland, and another from Stad to Shetland, in which the isotherms are shown in vertical sections. With this exception, the bottom-temperatures only, on the slopes of the banks, have been used, and the lines made to agree with the vertical sections and the maps of isotherms for the different depths. The effect of the land-cold will be seen in the upper strata. South of Vesteraalen (lat. 69° N) the isotherms for 0° to 5° lie very close. The following Table, in which the figures have been taken from the profile, gives the depths of the isotherms on the bank and their maximum-depth out at sea for 0° and — 1° on the different latitudes.

Isothermernes Dybde i Favne.
(Depth of Isotherms in Fathoms).

Bredde. (*Latitude*).	0 Grad (*0 Degree*). ved Banken. (*At the Bank*)	i Havet. (*In the Sea*).	— 1 Grad (*— 1 Degree*) ved Banken. (*At the Bank*).	i Havet. (*In the Sea*).
60°	440		580	
61	320	310	330	460
62	360	350	420	640
63	360	350	480	890
64	400	400	440	1080
65	360	370	380	1170
66	360	420	390	1180
67	350	430	400	1130
68	395	480	450	1160
69	470	500	610	1310
70	560	680	720	1310
71	490	610	660	1050
72	420	550	570	850
73	370	520	520	820
74	360	520	500	820
75	405	560	580	830
76	480	540	580	840
77	460	520	590	790
78	490	490	600	680
79	390	410	570	570
80	380	400	450	450

Man ser heraf, ligesom af Tversnittene Pl. XIV og XV, at det varme Vand har en mindre Dybde der, hvor det stoder til Grændseryggene mod Atlanterhavet end langs Norges og Spidsbergens Banker. Samtidig med at dets Bredde indskrænkes, voxer dets Dybde, indtil den naar sit Maximum under den 70. Breddegrad. Her sænke Dybets Isothermer sig saaledes, at selve Bundtemperaturen har et Maximum. Fra den 70. til den 74. Breddegrad hæve Dybets Isothermer sig, men længere mod Nord gaa de tildels igjen dybere, medens — 1° lofter sig, og ved 80° Bredde nærme de sig hverandre. I denne høje Bredde rækker 0° endnu ned til 400 Favnes Dyb.

Bundtemperaturerne ved Spidsbergens Nordkyst og Kuldegraderne langs Vestkysten indtil Isfjorden ere aflagte efter Lieutenant H. Chermieside's R. E. Iagttagelser i 1872 med "Samson" og i 1873 med "Diana" samt efter Palanders Iagttagelser fra 1873. Alle disse ere udførte med Miller-Casella-Thermometre.

We perceive from this, as also from the sections, Pls. XIV and XV, that the warm water lies at a less depth where it comes in contact with the boundary ridges of the Atlantic than it does on the Norway and Spitzbergen banks. When diminishing in breadth, it increases in depth, till, at the 70th parallel of latitude, its maximum is attained. There the isotherms of the deep descend in such wise that even the bottom-temperature has a maximum. From the 70th to the 74th parallel of latitude, the isotherms of the deep are found to rise, but farther north they again go partly deeper down, whereas the isotherm for — 1° rises, and in lat. 80° N they approach each other. In this high latitude 0° still reaches down to a depth of 400 fathoms.

The bottom-temperatures off the north coast and the temperatures below 0° along the west coast of Spitzbergen as far as Ice Sound have been set down from the observations of Lieutenant H. Chermieside, R. E, in 1872, with the "Samson," and in 1873, with the "Diana", as also from Palander's observations in 1873. All of these were taken with the Miller-Casella thermometer.

6. Temperaturens Fordeling paa de norske Kystbanker og i de norske Fjorde.

De hydrografiske Undersøgelser, der ere udførte af Norges geografiske Opmaaling, have vist, at de fleste norske Fjorde, der stikke fra Kysten ind i Landet, have sin største Dybde, ikke ved Mundingen, men længere inde, tildels i flere Miles Afstand fra Kysten. Ogsaa de ydre Fjorde, der paa Ydersiden begrændses af Øer, som Folden-

6. Distribution of Temperature on the Norwegian Coastal Banks and in the Norwegian Fjords.

The hydrographic investigations instituted by the Norwegian Geographical Survey, have shown that most of the Norwegian fjords extending inland from the coast are deepest, not at their mouth but farther in, in some places many miles from the coast. Moreover the outerlying fjords, bounded seaward by islands, such as the Foldenfjord and the Vest-

fjorden og Vestfjorden, vise lignende Forhold, og til samme Klasse slutter den norske Rende i Skagerak sig. Istedetfor en Kystbanke med jevn Overflade har man paa saadanne Steder Dybbassiner i Form af forholdsvis smale Render, der gaa i Fjordens Retning. Paa enkelte Steder synes et saadant Dybbassins Udstrækning at være saa ringe, at det endog ikke har fundet Plads paa Opmaalingens Dybdekarter.

I 1871 foretoges den første nøjagtigere Temperaturmaaling i Dybet af en norsk Fjord, idet Professor Sexe velvilligen imødekom min Anmodning derom og maalte Temperaturen i Sørfjorden i Hardanger med et Miller-Casella-Thermometer. Siden den Tid er Temperaturen i Dybet af vore Fjorde og paa Bankerne jevnlig bleven undersøgt af forskjellige Expeditioner. Resultaterne heraf indtil 1875 ere meddelte i Petermanns Geographische Mittheilungen for 1876, Side 432—434. Derpaa følge Nordhavs-Expeditionens Undersøgelser, hvis Resultat ovenfor er meddelt i Tabellen Side 44—61. Fra 1879 af er der hvert Aar taget Dybtemperaturer fra Oplodningsdampskibet "Hansteen" med Negretti & Zambra's Vendethermometer, verificeret saavel ved det meteorologiske Institut som ved directe Sammenligning ombord med Normalthermometer. Disse interessante Observationer, der velvilligen ere mig overladte til Afbenyttelse, betegner jeg i det følgende med H. No. 1, H. No. 2 o. s. v.

Idet jeg nu gaar over til den følgende Discussion af Temperaturiagttagelserne paa vore Banker og i vore Fjorde, begynder jeg med den norske Rende i Skagerak og følger derfra Kysten nordover.

I Skagerak-Renden fandt den tyske "Pommerania"-Expedition i 1872 omkring 6° i 100 Favnes Dyb og 5°.0 til 5°.9 i 200 Favnes Dyb samt 5°.0 i Dybder omkring 300 Favne. Med "Hansteen" maaltes følgende Temperaturer (den første Række med Miller-Casella, den anden med Negretti & Zambra's Vendethermometer).

fjord, exhibit similar depressions, and to this class belongs the Norwegian Channel, in the Skagerak. In place of a coastal bank with an even surface, we have in such localities deep basins, taking the form of comparatively narrow channels, that follow the direction of the fjord. In some places, the extent of such a deep basin would seem to be so trifling, that the Geographical Survey has not found room for it in the deep-sea charts.

In 1871, was undertaken the first trustworthy measurement of temperature in the depths of a Norwegian fjord, Professor Sexe having kindly acceded to my proposal and registered the temperature in the Sørfjord, Hardanger, with a Miller-Casella thermometer. Since then, the temperature in the depths of our fjords, and on the banks, has been periodically determined on various Expeditions. The results, up to 1875, will be found in Petermann's Geographische Mittheilungen for 1876, p. 432—434. Next come the explorations of the Norwegian North-Atlantic Expedition, the results of which have been given in the Table, p. 44—61. Dating from the year 1879, deep-sea temperatures have been taken every year by the Coast Survey steamer "Hansteen," with Negretti and Zambra's inverting-thermometer, verified alike at the Meteorological Institute and by direct comparison on board with the Standard Thermometer. These interesting observations, kindly placed at my disposal, I shall designate in the sequel H. No. 1, H. No. 2, and so on.

Proceeding now to discuss the temperature-observations taken on the Norway banks and in the fjords, I shall begin with the Norwegian Channel, in the Skagerak, following from thence the coast northwards.

In the Skagerak Channel, the German "Pommerania" Expedition found, in 1872, about 6° at a depth of a hundred fathoms, 5°.0 to 5°.9 at a depth of 200 fathoms, and 5°.0 at a depth of 300 fathoms. On board the "Hansteen," the following temperatures were registered — the first series with the Miller-Casella thermometer, the others with Negretti & Zambra's inverting instrument.

H. No. 1

1877. Sept. 4.
58° 14′ N. Br. 9° 12′ E. Lgd.

Dybde i Favne. (*Fathoms.*)	Meter.	Temp.
0	0	13°.3
10	18	7.9
20	37	5.7
30	55	5.0
40	73	5.1
50	91	5.0
75	137	5.3
100	183	5.3
150	274	5.3
Bund (*Bottom*) 340	622	5.2

H. No. 2

1880. Maj 20.
58° 5′ N. Br. 9° 0′ E. Lgd.

Dybde i Favne. (*Fathoms.*)	Meter.	Temp.
0	0	9°.8
5	9	9.0
10	18	8.8
20	37	7.7
30	55	6.5
40	73	5.9
50	91	5.7
60	110	6.0
80	146	6.0
100	183	6.0
150	274	6.0
200	366	5.7
300	549	5.0
Bund (*Bottom*) 345	631	5.0

Man ser heraf, at Temperaturen i Dybet under 100 Favne til Bunden ikke er ganske constant, men varierer noget, idet den langsomt aftager ovenfra mod Bunden, hvor den stadig er funden omkring 5⁰. I 200 Favnes Dyb varierer den fra 5⁰.0 til 5⁰.9 og i 100 Favnes Dyb fra 5⁰.3 til 6⁰.0. Temperaturen varierer i samme Aar fra Sted til Sted (Pommerania) og paa nærliggende Steder (Hansteen) fra det ene Aar til det andet.

Da Indexthermometrene ikke ere istand til at angive Temperaturen i Dybet nøjagtig, naar denne baade aftager og stiger med Dybet i samme Vertical, men Vendethermometret registrerer rigtigt, holder jeg mig i den nærmest følgende Beskrivelse til de Temperaturer, der ere maalte med det sidste.

I Aakrefjorden (59⁰ 50′ N. Br.) maalte vor Expeditions Chemiker, H. Tornøe, Sommeren 1884 12 Rækker Dybvandstemperaturer.[1] Af disse fremgaar det, at Temperaturen paa Dybet fra 100 Favne til Bunden (største Dybde 333 Fv. = 610 Meter) er temmelig constant, 6⁰.5 til 6⁰.7.

I Sognefjorden (61⁰ 10′ N. Br.) maaltes fra "Hansteen" den 9. Juni 1879 mellem Ladvik og Oppegaard følgende Temperaturrække.

This shows, that the temperature in the deep below 100 fathoms to the bottom is not strictly constant, but varies somewhat, diminishing slowly towards the bottom, where it invariably has been found about 5⁰. At a depth of 200 fathoms, it varies from 5⁰.0 to 5⁰.9, and at a depth of 100 fathoms, from 5⁰.3 to 6⁰.0. The temperatures differ in one and the same year from place to place ("Pommerania"), and in localities lying comparatively close together ("Hansteen") from year to year.

The index-thermometers not being able to register the temperature in the deep with strict accuracy when such temperature both diminishes and increases with the depth in the same vertical, whereas the inverting-thermometer indicates correctly, I shall confine myself in the following description to temperatures measured with the latter instrument.

In the Aakrefjord (lat. 59⁰ 50′ N) the chemist to our Expedition, Mr. H. Tornøe, registered during the summer of 1884, 12 serial deep-sea temperatures.[1] From these it is manifest that the temperature in the deep from 100 fathoms to the bottom (greatest depth 333 fms. = 610 metres) is comparatively constant, viz., as 6⁰.5 to 6⁰.7.

In the Sognefjord (lat. 61⁰ 10′ N), the following serial temperatures were taken on board the "Hansteen," 9 June 1879, between Ladvik and Oppegaard.

H. No. 3.

Favne. (*Fms.*)	Meter.	Temp.	Favne, (*Fms.*)	Meter.	Temp.	Favne, (*Fms.*)	Meter.	Temp.
0	0	12⁰.0	50	91	7⁰.5	309	565	6⁰.6
10	18	10 .0	103	188	6 .8	412	753	6 .5
20	37	8 .5	154	282	6 .7	515	942	6 .5
30	55	7 .5	206	377	6 .7	618	1130	6 .5
						B. 680	1244	6 .5

Fra 100 Favne til 400 Favne aftager Temperaturen kun 0⁰.2, og fra 400 Favne til Bunden i 680 Favne er den absolut constant 6⁰.5.

I 1872 fandt jeg, noget længere inde i Fjorden, i 400 til henimod 700 Favne 6⁰.2. Nordhavs-Expeditionen fandt i 1876 6⁰.6.

I Throndhjemsfjorden (63⁰ 35′ N. Br.) toges fra "Hansteen" følgende Temperaturrækker:

From 100 to 400 fathoms, the temperature diminishes only 0⁰.2, and from 400 fathoms to the bottom, at a depth of 680 fathoms, it is absolutely constant, viz., 6⁰.5.

In 1872, I registered, somewhat farther up the fjord, at a depth of 400 to close upon 700 fathoms, 6⁰.2. The North-Atlantic Expedition found in 1876 a temperature of 6⁰.6.

In the Throndhjemsfjord (lat. 63⁰ 35′ N), the following serial temperatures were taken on board the "Hansteen:"

[1] Nyt Magazin for Naturvidenskaberne 29. Bind. S. 295.

[1] Nyt Magazin for Naturvidenskaberne, Vol. 29, p. 295.

H. No. 4.

1881. September 21.

Tvers af Blaaheja noget indenfor Selva.
(Off Blaaheja, a little within Selva).

Favne. (*Fms.*)	Meter.	Temp.
0	0	10°.7
5	9	10 .2
10	18	10 .2
20	37	8 .6
30	55	6 .5
40	73	7 .2
50	91	6 .9
77	140	6 .2
103	188	6 .0
155	283	6 .1
206	377	6 .2
257	470	6 .4
B. 309	565	6 .3

H. No. 5.

1882. September 15.

Midt mellem Agdanes og Rodberget.
(Midway between Agdanes and Rødberget).

Favne. (*Fms.*)	Meter.	Temp.
0	0	13°.1
5	9	13 .1
10	18	13 .0
20	37	12 .6
30	55	11 .9
40	73	10 .4
50	91	9 .2
61	112	7 .9
82	150	7 .5
103	188	7 .3
155	283	7 .3
206	377	7 .25
257	470	7 .2
B. 319	583	7 .2

H. No. 6.

1883. September 11.

Midt mellem Agdenes og Rødberget.
(Midway between Agdanes and Rødberget).

Favne. (*Fms.*)	Meter.	Temp.
0	0	12°.8
6	10	12 .3
11	20	12 .0
37	50	11 .2
49	70	10 .4
55	100	8 .1
82	150	6 .2
110	200	6 .2
164	300	6 .2
219	400	6 .2
274	500	6 .2
B. 328	600	6 .2

I Dybder større end 100 Favne viser Temperaturen paa samme Sted og Tid sig temmelig constant. Paa Observationsstedet No. 5 og 6 er der mellem 1882 og 1883 en Forskjel af en hel Grad i Dybets constante Temperatur, 7°.2 mod 6°.2. No. 5 ligger længere ude mod Mundingen af Fjorden. I 1872 fandt jeg ved Throndhjem i 100 til 170 Favnes Dyb 6°.6 og 6°.5 og længere inde i Fjorden ved Ytterøen i 100 Favne 6°.2, i 188 Favne 5°.9. Den i vertical Retning constante Dybtemperatur i Throndhjemsfjorden varierer altsaa noget med Stedet og med Tiden.

I Folden-Fjord ligger en Dybrende efter Fjordens Axe. I denne har man fra "Hansteen" taget følgende Temperaturrækker.

Throughout depths exceeding 100 fathoms, the temperature at the same place and time is found to be comparatively constant. In the locality for observation No. 5 and No. 6, there is a difference from 1882 to 1883 of a whole degree in the constant temperature of the deep, viz., 7°.2 against 6°.2. No. 5 lies farther out towards the mouth of the fjord. In 1872, I registered at Throndhjem, at a depth of 100 to 170 fathoms, 6°.6 and 6°.5; and farther up the Fjord, near Ytterø, at a depth of 100 fathoms, 6°.2, at a depth of 188 fathoms, 5°.9. The constant deep-temperature in a vertical direction throughout the Throndhjemsfjord, varies therefore somewhat with place and time.

In the Foldenfjord extends a deep-channel in the direction of the axis of the fjord. In this channel, the following serial temperatures have been taken from the "Hansteen."

H. No. 7.

1880. Juli 22.

64° 34′ N. Br. 10° 27′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	11°.4
5	9	11 .1
10	18	9 .2
20	37	7 .4
30	55	6 .8
40	73	7 .1
61	112	7 .3
82	150	7 .2
103	188	7 .4
124	227	7 .5
155	283	7 .3
B. 196	358	7 .0

H. No. 8.

1880. August 18.

64° 40′ N. Br. 10° 47′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	14°.3
5	9	12 .6
10	18	13 .3
20	37	10 9.
30	55	9 .5
35	64	7 .5
40	73	7 .3
51	93	7 .9
61	112	7 .5
82	150	7 .2
103	188	7 .2
B. 217	397	7 .2

H. No. 9.

1884. August 13.

64° 47′ N. Br. 11° 24′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	14°.0
6	10	13 .5
14	25	12 .9
27	50	11 .8
41	75	9 .4
55	100	8 .2
82	150	7 .3
110	200	7 .0
B. 177	325	6 .9

Under 100 Favne er Temperaturen i samme Vertical constant (No. 8) eller svagt aftagende med Dybden. Fra Sydvest mod Nordost, fra Havet mod Land, er den gjennemsnitlige Dyb-Temperatur aftagende.

Udenfor Folden-Fjorden ligger en Banke, der grunder op til 60 Favne Vand. Mellem denne og Kysten strækker sig en Dybrende, adskilt fra Foldenfjordens ved en grundere Ryg. I den første har man fra "Hansteen" taget følgende Temperaturrækker.

Below 100 fathoms, the temperature in the same vertical is constant (No. 8), or diminishes slightly with the depth. From the south-west to the north-east, or from the sea towards the land, the average deep-temperature is found to decrease.

Off the Foldenfjord, lies a bank on which the water shoals up to 60 fathoms. Between this bank and the coast, extends a deep-channel, cut of from that of the Foldenfjord by a shallower ridge. In the former, the following serial temperatures were taken from the "Hansteen."

H. No. 10.
1880. Juli 21.
64° 34′ N. Br. 9° 21′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	12°.4
5	9	12 .2
10	18	10 .2
20	37	8 .0
30	55	7 .5
40	73	7 .5
61	112	7 .4
82	150	7 .2
124	227	7 .0
B. 144	263	6 .9

H. No. 11.
1880. Juli 9.
64° 40′ N. Br. 9° 20′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	11°.8
10	18	11 .1
20	37	10 .4
30	55	8 .4
40	73	7 .9
50	91	7 .4
61	112	7 .5
82	150	7 .3
103	188	7 .6
155	283	7 .2
B. 206	377	6 .9

H. No. 12.
1880. Juli 29.
64° 50′ N. Br. 9° 26′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	12°.1
5	9	12 .0
10	18	11 .5
20	37	9 .4
30	55	8 .6
40	73	8 .2
61	112	7 .7
82	150	7 .3
103	188	7 .0
B. 127	232	6 .9

H. No. 13.
1880. Juli 29.
64° 48′ N. Br. 10° 5′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	12°.2
5	9	11 .3
10	18	11 .2
20	37	10 .0
30	55	9 .2
40	73	8 .4
61	112	8 .0
82	150	7 .9
103	188	7 .7
129	236	7 .4
155	283	7 .0
B. 221	404	6 .8

Temperaturen er synkende fra 100 Favne til Bunden. Observationerne stemme vel overens med de paa Nordhavs-Expeditionen i det samme Strøg i 1876 maalte (No. 55 til No. 61) Bundtemperaturer, der gaa fra 7°.2 til 6°.9.

Paa Vestsiden af den ovennævnte Banke har "Hansteen" to Temperaturrækker.

The temperature continues sinking from a depth of 100 fathoms to the bottom. The observations exhibit excellent agreement with the bottom-temperatures — from 7°.2 to 6°.9; Nos. 55—61 — registered on the North-Atlantic Expedition in 1876 throughout the same tract.

On the west side of the aforesaid bank, we have two serial temperatures from the "Hansteen."

H. No. 14.
1880. Juli 21.
64° 36′ N. Br. 8° 15′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	12°.2
5	9	11 .5
10	18	11 .4
20	37	10 .8
30	55	9 .8
40	73	8 .7
61	112	7 .8
82	150	7 .2
103	188	6 .9
B. 115	210	6 .9

H. No. 15.
1880. Juli 28.
64° 50′ N. Br. 8° 22′ E. Lgd.

Favne. (*Fms*).	Meter.	Temp.
0	0	12°.2
5	9	12 .0
10	18	11 .6
20	37	9 .0
30	55	8 .4
40	73	8 .0
61	112	7 .7
82	150	7 .2
B. 111	203	6 .8

Temperaturen aftager med Dybden i de dybere Lag. Paa Nordhavs-Expeditionen fandtes midt imellem disse Punkter (Station No. 67) i 119 Favnes Dyb 6°.9. Altsaa en meget nær Overensstemmelse.

The temperature diminishes with the depth in the deeper strata. On the North-Atlantic Expedition, a temperature of 6°.9 was measured midway between these points (Station No. 67), at a depth of 119 fathoms. Accordingly, a very close agreement.

Udenfor Fiskeværet Sklinda har "Hansteen" følgende tre Temperaturrækker.

Off the island of Sklinda, the following three serial temperatures were taken on board the "Hansteen."

H. No. 16.
1881. August 31.
65° 16′ N. Br. 9° 47′ E. Lgd.

Favne. (Fms.)	Meter.	Temp.
0	0	12°.1
5	9	12 .0
10	18	11 .6
20	37	10 .6
30	55	9 .9
40	73	9 .2
50	91	8 .4
61	112	8 .3
82	150	7 .6
B. 105	192	7 .2

H. No. 17.
1881. August 31.
65° 16′ N. Br. 10° 27′ E. Lgd.

Favne. (Fms.)	Meter.	Temp.
0	0	12°.2
5	9	12 .0
10	18	11 .9
20	37	11 .0
30	55	10 .8
40	73	10 .0
50	91	9 .2
61	112	8 .4
82	150	7 .6
B. 113	207	7 .3

H. No. 18.
1881. August 31.
65° 16′ N. Br. 11° 0′ E. Lgd.

Favne. (Fms.)	Meter.	Temp.
0	0	12°.0
5	9	11 .9
10	18	11 .1
20	37	11 .0
30	55	10 .3
40	73	9 .7
50	91	8 .2
77	141	7 .0
B. 103	188	6 .4

Mellem No. 16 og No. 17 ligger en Banke paa 70 Favne, mellem No. 17 og No. 18 et Dyb paa 150 Favne. Bundtemperaturen er lavest under Kysten (No. 18) og har et Maximum paa Bankens Østside (No. 17). Lidt nordenfor, i Dybet paa Østsiden af Banken, fandt Nordhavs-Expeditionen i 1877 (Station No. 107) 6°.1 i 100 Favne og 6°.25 i 172 Favne, altsaa noget lavere Temperatur. I Nordvest og Nord for Banken fandt vi (Station No. 103 til 105) 6°.4 til 6°.6 i 194 til 145 Favnes Dyb.

Between No. 16 and No. 17, extends a bank at a depth of 70 fathoms; between No. 17 and No. 18, a deep reaching 150 fathoms. The bottom-temperature is lowest in immediate proximity to the coast (No. 18), and has a maximum on the eastern slope of the bank (No. 17). A little farther north, in the deep on the east side of the bank, 6°.1 was registered on the North-Atlantic Expedition, in 1877 (Station No. 107), at a depth of 100 fathoms, and 6°.25 at a depth of 172 fathoms, accordingly a somewhat lower temperature. North-west and north of the bank we found (Stations 103 to 105) 6°.4 to 6°.6, at a depth of 194—145 fathoms.

Søndenfor Vægø, i Nordvest for Brønø, har "Hansteen" følgende Temperaturrække.

South of Vægø, north-west of Brønø, the "Hansteen" took the following serial temperatures.

H. No. 19.
1882 Juli 17. 65° 28′ N. Br. 11° 52′ E. Lgd.

Favne. (Fms.)	Meter.	Temp.	Favne. (Fms.)	Meter.	Temp.	Favne. (Fms.)	Meter.	Temp.
0	0	12°.1	30	55	7°.8	82	150	6°.1
5	9	10 .8	40	73	7 .0	103	188	6 .2
10	18	10 .2	50	91	6 .1	155	283	6 .4
20	37	8 .5	61	112	6 .0	206	377	6 .7
						B. 273	499	6 .8

Opmaalingens Dybdekart angiver ikke dette Dyb, men en Banke paa mindre end 100 Favnes Dyb rundt omkring. Temperaturen har et Minimum i 60 Favnes Dyb, og voxer derfra stadig mod Bunden. Stedet ligger omgivet paa næsten alle Sider af Skjærgaard, og ikke langt fra Kysten. Det er saaledes i høj Grad udsat for Landkuldens Paavirkning.

I Vest for Vægø ligger, mellem den 65. og 66. Breddegrad, en Indsænkning i Kystbanken paa over 200 Favnes Dyb. Ved dennes sydlige, østlige og nordlige Rand har "Hansteen" følgende Temperaturrækker.

The Chart of Depth of the Coast Survey does not mark this deep, but a bank extending round at less than 100 fathoms. The temperature has a minimum at a depth of 60 fathoms, increasing from thence steadily to the bottom. The locality is surrounded on well-nigh every side by skerries, and does not lie far from the coast. Hence, it is exposed in a high degree to the influence of the "land-cold."

West of Vægø, between the 65th and 66th parallels of latitude, occurs a depression in the coastal bank, at a depth of more than 200 fathoms. On its southern, eastern, and northern margins, the following serial temperatures were taken on board the "Hansteen."

H. No. 20.

1882. Juni 23.

65° 30′ N. Br. 9° 40′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	11°.9
5	9	11 .0
10	18	10 .6
20	37	9 .4
40	73	8 .0
61	112	7 .4
82	150	7 .2
103	188	7 .1
B. 185	338	6 .7

H. No. 21.

1882. Juli 17.

65° 35′ N. Br. 10° 30′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	14°.1
5	9	13 .8
10	18	13 .3
20	37	11 .8
30	55	9 .5
40	73	8 .3
61	112	7 .7
82	150	7 .2
103	188	7 .0
155	283	7 .0
B. 221	404	6 .9

H. No. 22.

1883. Juni 27.

65° 50′ N. Br. 9° 43′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	13°.4
8	15	11 .8
17	30	9 .6
28	50	8 .3
55	100	6 .8
82	150	6 .7
110	200	6 .7
137	250	6 .4
B. 181	330	6 .4

I denne Indsænkning har Nordhavs-Expeditionen, længere mod Vest, i 1877 maalt Bundtemperaturer paa 6°.0 til 6°.4 (Station No. 100 til 103) altsaa merkelig lavere end "Hansteens."

Nordvest for Vægø ligger en "Fiskebanke", udenfor hvilken "Hansteen" har følgende Temperaturrække:

In the said depression, the bottom-temperature was measured, farther west, on the North-Atlantic Expedition, in 1877, and found to be from 6°.0 to 6°.4 (Station No. 100 to 103), hence appreciably lower than registered on board the "Hansteen."

North-west of Vægø there is a fishing-bank, off which the "Hansteen" took the following serial temperatures.

H. No. 23.

1883. Juni 28. 65° 52′ N. Br. 11° 25′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.	Favne. (*Fms.*)	Meter.	Temp.	Favne. (*Fms.*)	Meter.	Temp.
0	0	13°.2	17	30	9°.0	55	100	6°.5
8	15	10 .6	33	60	8 .6	71	130	5 .9
						B. 93	170	5 .9

Temperaturen ved Bunden er temmelig lav.

Langs den 66. Breddegrad har "Hansteen" følgende Temperaturrækker.

The temperature at the bottom is rather low.

Along the 66th parallel of latitude, the following serial temperatures were taken on board the "Hansteen."

H. No. 24.

1883. Juli 24.

66° 2′ N. Br. 9° 39′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	14°.8
6	10	14 .2
11	20	13 .7
22	40	11 .4
33	60	9 .2
55	100	6 .8
77	140	6 .7
99	180	6 .6
B. 135	246	6 .3

H. No. 25.

1884. Sept. 3.

66° 0′ N. Br. 10° 57′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	13°.3
6	10	13 .1
13	24	12 .9
27	49	10 .4
42	77	8 .5
55	100	7 .7
82	150	7 .2
110	200	7 .0
137	250	7 .0
B. 170	311	6 .9

H. No. 26.

1883. August 6.

66° 2′ N. Br. 11° 21′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	14°.2
27	50	8 .0
39	70	7 .0
55	100	6 .2
B. 95	174	6 .6
66° 2′ N. Br. 11° 18′ E. Lgd.		
0	0	15°.0
B. 137	250	6 .8
65° 59′ N. Br. 11° 26′ E. Lgd.		
B. 36	66	6°.6
66° 2′ N. Br. 11° 27′ E. Lgd.		
B. 40	74	5°.9
65° 59′ N. Br. 11° 30′ E. Lgd.		
B. 71	130	6°.0

H. No. 27.

1883. Juli 3.

66° 0′ N. Br. 11° 54′ E. Lgd.

Favne (*Fms.*)	Meter.	Temp.
0	0	11°.0
6	10	10 .7
11	20	9 .8
22	40	8 .0
33	60	7 .4
55	100	6 .2
82	150	5 .9
110	200	6 .0
137	250	6 .0
B. 175	320	6 .0

No. 24 og 25 ligge paa den lidt bølgeformede Banke. No. 26 ligger paa en „Fiskebank“, hvis Top ligger i Længden 11° 26′ E. Paa Vestsiden af denne Bank ere Bundtemperaturerne over 6°.6, men paa Østsiden gaa de ned til under 6°. No. 27 ligger i Dønnes-Fjorden vestenfor Dønnesøen. Temperaturen har et Minimum i 80 Favnes Dyb og er constant 6° fra 100 Favne til Bunden i 175 Favne.

Udenfor Mundingen af Vestfjorden har "Hansteen" følgende 3 Temperaturrækker.

Nos. 24 and 25 lie on the sligthly undulating bank. No. 26 is located on a "fishing-bank," the summit of which lies in long. 11° 26′ E. On the west side of this bank, the bottom-temperatures reach upwards of 6°.6, but on the east side they sink below 6°. No. 27 lies in the Dønnes Fjord, west of the island of that name. The temperature has a minimum at a depth of 80 fathoms, and is constant at 6° from a depth of 100 fathoms to the bottom, in 175 fathoms.

Off the mouth of the Vestfjord, the "Hansteen" has the following 3 serial temperatures: —

H. No. 28.

1885. August 1.

67° 3′ N. Br. 12° 25′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	11°.6
14	25	10 .1
27	50	9 .0
38	70	8 .3
55	100	6 .8
82	150	6 .8
110	200	6 .8
B. 150	273	6 .6

H. No. 29.

1885. August 21.

67° 8′ N. Br. 13° 4′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	11°.9
14	25	11 .3
27	50	10 .3
38	70	8 .2
82	150	7 .0
110	200	6 .7
B. 153	280	6 .7

H. No. 30.

1885. September 1.

67° 19′ N. Br. 12° 55′ E. Lgd.

Favne. (*Fms.*)	Meter.	Temp.
0	0	11°.0
14	25	10 .8
27	50	10 .1
38	70	9 .1
55	100	8 .3
82	150	6 .8
B. 121	220	6 .8

Imellem Røst og Bodø strækker sig en Forhøjning i Havbunden, der paa dens dybeste Parti sænker sig til 120 Favne under Havfladen og begrændser Vestfjordens Bassin. No. 28 ligger udenfor (søndenfor) denne Ryg. No. 29 ligger i en Fordybning udenfor Mundingen af Saltenfjorden, ogsaa søndenfor Ryggen. No. 30 ligger paa Ryggen, ved dens dybeste Parti. Paa alle 3 Steder ere Bundtemperaturerne forholdsvis høje. Paa et Punkt, noget i Nordost for No. 30, hvor Dybden er 150 Favne, maaltes paa Nordhavs-Expeditionen d. 22. Juni 1877 (Station No. 148) i 100 Favne 4°.3, i 140 Favne 5°.0; den 18. August samme Aar fandtes i 100 Favne 5°.1 og i 140 Favne 5°.8 (Station No. 254). Temperaturen var saaledes i mindre end 2 Maaneder steget 0°.8. Et Temperatur-Minimum fandtes i 60 Favnes Dyb. Forholdene i 1877 ere saaledes temmelig afvigende fra dem, som paa nærliggende Sted fandtes i 1885.

Den inderste Del af Vestfjorden danner et Dybbassin paa indtil 350 Favnes Dyb. Her fandt vor Expedition i Juni 1878 (Station No. 255) i 100 Favnes Dyb 5°.9 og i 300 til 340 Favnes Dyb 6°.5. Udenfor Lødingen (68° 24′ N. Br. 16° 1′ E. Lgd.) har Telegrafinspectør Lie, ved Foranstaltning af Opsynschefen ved Lofotfisket, Captein i Marinen N. Juel, maalt i Aarene 1879 og 1880 Temperaturen paa Dybet indtil 100 Favne i Maanederne Maj til næstfølgende Januar. Disse Observationer skal jeg nedenfor meddele i større Omstændelighed. I begge Aar fandtes her, hvor Vestfjorden ender, i 100 Favnes Dyb en Temperatur, der kun varierer fra 6°.2 til 6.°5 og i Gjennemsnit er 6°.4. Den svarer saaledes nærmere til det dybeste Lags Temperatur end til Temperaturen i 100 Favne i Vestfjorden i 1878.

Between Røst and Bodø stretches an elevation of the sea-bed, which, in its deepest part, sinks to 120 fathoms beneath the surface, and limits the basin of the Vestfjord. No. 28 is located off (south of) this ridge. No. 29 lies in a depression off the mouth of the Saltenfjord, also south of the ridge. No. 30 lies on the ridge — its deepest part. In each of these localities the bottom-temperatures are comparatively high. At one point, a little to the north-east of No. 30, where the depth reaches 150 fathoms, was registered on the North-Atlantic Expedition, 22 June 1877 (Station No. 148), in 100 fathoms, 4°.3, in 140 fathoms 5°.0. On the 18th of August — same year — was found in 100 fathoms 5°.1, and in 140 fathoms 5°.8 (Station No. 254). The temperature had consequently risen in less than 2 months as much as 0°.8. A temperature-minimum was found to occur at a depth of 60 fathoms. Hence, in 1877, the temperature-relations deviate very considerably from those observed in an adjacent locality in 1885.

The inner part of the Vestfjord constitutes a deep basin, reaching down as low as 350 fathoms. Here the North-Atlantic Expedition registered in June 1878 (Station No. 255), at a depth of 100 fathoms, 5°.9, and in 300 to 340 fathoms 6°.5. Off Lødingen (lat. 68° 24′ N, long. 16° 1′ E), Mr. Lie, Inspector of Telegraphs, measured, at the requisition of Capt. N. Juel, R. N., Chief Inspector of the Lofoten Fishery, in the years 1879 and 1880, the temperature to a depth of 100 fathoms from the month of May to the month of January in the following year. These observations I shall communicate below in greater detail. Both years was found here, at the point where the Vestfjord terminates, with a depth of 100 fathoms, a temperature varying only from 6°.2 to 6°.5, and averaging 6°.4.

I Juli 1875 fandt jeg med Miller-Casella-Thermometer i disse Dybder i Vestfjorden 6°.2 til 6°.3.

Vor Station No. 168 viser en constant Temperatur af 2°.3 fra 400 til 444 Favne og antyder saaledes Tilstedeværelsen af en isoleret Fordybning i Banken paa 68° 39′ N. Br., 11° 51′ E. Lgd. Lidt længere Vest (No. 166, 11° 40′ E. Lgd.) er Bundtemperaturen 0°.1 i 406 Favnes Dyb. Denne Station ligger saaledes paa Ydersiden af den Ryg, der begrændser Fordybningen, og Ryggen rækker op til adskilligt højere end 400 Favne, da Temperaturen paa dens Kam maa være over 2°.3.

I Alten-Fjorden (70° N. Br.) fandt vor Expedition den 21. Juni 1878 i 100 Favne 2°.5 og i 150 til 225 Favne 4°.0 (Station 256 og 257). Den norske Polarstation maalte fra September 1882 til September 1883 en Gang om Maaneden Temperaturen i Altenfjorden paa et Sted noget længere øst og syd (70° 2′ N. Br., 23° 14′ E. Lgd., mellem Bratholmen og Alteneslandet), hvor Dybden var lidt over 100 Favne. I 100 Favnes Dyb fandtes Temperaturen varierende fra 4°.5 (Januar, Februar og October) til 5°.2 (April og Maj) og den var i Middel 4°.9, altsaa meget højere end den fandtes i 1878. I 1873 fandt jeg med Miller-Casella i Altenfjorden i 100 Favne 4°.0 og i 150 til 200 Favne 3°.2 til 3°.3.

I Varangerfjorden fandt jeg i August 1875 udenfor Bøgfjord med Miller-Casella i 100 Favne 2°.6 og i 150 til 224 Favne 2°.9 til 3°.1. I 1876 fandt man med "Hansteen" længere ude i Fjorden i en anden Fordybning i Syd for Vardø med samme Instrument i 237 Favnes Dyb 5°.7. I 1881 fandt den franske Expedition med "Coligny" (Prof. Pouchet, Capt. Martial)[1] meget lavere Temperaturer, 1°.5 i 100 Favnes Dyb og 1°.3 ved 200 Favnes Dyb.

Efter denne Oversigt viser det sig, at der i Dybder paa over 100 Favne paa vore Kystbanker i forskjellige Aar i samme Dybde paa nærliggende Steder optræde merkelig forskjellige Temperaturer, paa samme Tid som Iagttagelser, udførte paa samme Sted (Lødingen og Alten-Fjord) gjennem et helt Aar, i 100 Favnes Dyb udvise kun ganske ringe Variationer. Jeg har gjort et Forsøg paa at sætte de fundne Variationer i Forbindelse med den foregaaende Tidsperiodes Temperaturtilstand i Havets Overflade paa Kysten og i Atmosfæren. I enkelte Tilfælder synes der at være Overensstemmelse tilstede. Saaledes skyldes aabenbart den lave Temperatur i Varangerfjorden i Sommeren 1881 den usædvanlig kolde Vinter og Vaar i Finmarken, da Luftens Temperatur fra October 1880 til Juni 1881 i Vardø var 2°.5 til 4° under Normaltemperaturen, og da der om Vaaren

[1] Comptes rendus 1882. S. 1.

Hence, it exhibits closer approximation to the temperature of the deepest strata than to the temperature as found at a depth of 100 fathoms in the Vestfjord in 1878. In July 1875, I registered with the Miller-Casella thermometer in these depths of the Vestfjord 6°.2 to 6°.3.

Our Station No. 168 shows a constant temperature of 2°.3 from 400 to 444 fathoms, and accordingly indicates the presence of an isolated depression in the Bank, lat. 68° 39′ N, long. 11° 51′ E. Somewhat farther west (No. 166, long. 11° 40′ E), the bottom-temperature is 0°.1 at a depth of 406 fathoms. This Station, therefore, lies on the outer slope of the ridge that bounds the depression, and the ridge reaches up considerably higher than 400 fathoms, since the temperature on its crest must be over 2°.3.

In the Altenfjord (lat. 70° N), our Expedition registered on the 21st of June 1878, in 100 fathoms, 2°.5, and in 150 to 225 fathoms, 4°.0 (Stations 256 and 257). At the Norwegian Polar Station, the temperature in the Altenfjord was measured once a month, from September 1882 to September 1883, in a locality somewhat farther east and south (lat. 70° 2′ N, long. 23° 14′ E), between Bratholmen and Altenesland, where the depth reached a little over 100 fathoms. At a depth of 100 fathoms, the temperature was found to vary from 4°.5 (January, February, and October) to 5°.2 (April and May), the mean being 4°.9; hence, very considerably higher than found in 1878. In 1873, I registered in the Altenfjord with a Miller-Casella thermometer, at a depth of 100 fathoms, 4°.0, and at depths of 150 to 200 fathoms, 3°.2 to 3°.3.

In the Varangerfjord, I measured in August 1875, off the Bøgfjord, with a Miller-Casella thermometer, at a depth of 100 fathoms, 2°.6, and at depths of 150 to 224 fathoms, 2°.9 to 3°.1. In 1876, farther out the fjord, in another depression, south of Vardø, was found on board the "Hansteen," with the same instrument, at a depth of 237 fathoms, 5°.7. In 1881, the French Expedition with the "Coligny" (Prof. Pouchet, Capt. Martial[1]) found much lower temperatures, viz., 1°.5 at a depth of 100 fathoms and 1°.3 at a depth of 200.

From these observations, it appears that in depths of more than 100 fathoms on the Norway coastal banks, in different years, at the same depth, in closely adjacent localities, remarkably variable temperatures are found to occur, while observations taken at one and the same place (Lødingen and the Altenfjord) a whole year round, at a depth of 100 fathoms, exhibit but very trifling variations. I have sought to place the said variations in connexion with the temperature observed during the preceding period at the surface of the sea, on the coast, and in the atmosphere. In some cases, there would seem to be agreement. Thus, for example, the low temperature in the Varangerfjord during the summer of 1881, must obviously be ascribed to the unusually cold winter and spring in Finmark, when the temperature of the air in Vardø, from Oc-

[1] Comptes rendus 1882, p. 1.

drev store Ismasser udenfor Finmarkens Kyst. Men paa den anden Side synes Temperaturen i 100 Favnes Dyb ved Lødingen i 1879 og 1880 og i Altenfjorden 1882—83 at være saa temmelig upaavirket af de vexlende Varmetilstande i Atmosfæren og i Havets Overflade. Det foreliggende Materiale strækker ikke til for at udrede den nærmeste Aarsag til de gjennem Iagttagelserne paaviste Variationer af Temperaturen paa Bankerne og i Fjorddybene. Det positive Resultat er, at der existerer Variationer, der synes at være af uperiodisk Natur.

I Fjorddybene og i Dybbassiner paa Bankerne finde vi i de større Dyb en i vertical Retning constant Temperatur. Det er det samme Fænomen, som er fundet i indelukkede Have, som Middelhavet, Banda Søen, Sulu Søen, m. fl. Dersom den constante Dybtemperatur væsentlig hidrørte fra Atmosfærens Varme, skulde den nærmest svare til den midlere aarlige Lufttemperatur. Thi saavel Vinter som Sommer forblive de af Luften directe paavirkede Vandlag øverst, paa Grund af deres i Modsætning til Dybet ringere Saltholdighed, et Forhold, der om Vinteren ikke rokkes ved, at Overfladens Temperatur er lavest, og som om Sommeren understøttes af Overfladens højere Temperatur. Varmens eller Kuldens Forplantning foregaar nedad kun ved Ledning. Noget anderledes turde Forholdet stille sig om Vinteren i længere Afstand fra Land, hvor Overfladevandet er saltere, idet dette ved Afkjøling kan faa en Tendents til at synke ned i de underliggende varmere og derfor lettere Lag og saaledes forplante Vinterkulden ved Strømninger nedad i Dybet. I saa Fald vil Vinterens Lufttemperatur faa en overvejende Indflydelse paa Dybets Temperatur, som f. Ex. Tilfældet er i Middelhavet. Skageraksdybet turde være under lignende Indflydelse af Vinterens Lufttemperatur.

Sammenstille vi Dyb-Temperaturen i vore Fjorde og andre Dybbassiner paa Bankerne med Luftens normale Temperatur for Aaret og for Vintermaanederne (December, Januar, Februar), faa vi den i den følgende Tabel givne Oversigt. I denne er medtaget Dybtemperaturer, maalte med Miller-Casella-Thermometre, der have vist en stadig Aftagen af Temperaturen med Dybden.[1]

[1] Petermanns Geographische Mittheilungen 1876. S. 432—433.

tober 1880 to June 1881 was 2°.5 to 4°.0 below the normal temperature, and when vast masses of ice kept drifting during the spring off the coast of Finmark. But, on the other hand, the temperature, in depths of 100 fathoms, at Lødingen during 1879 and 1880 and in the Altenfjord during 1882 and 1883, would appear to have been well-nigh uninfluenced by the varying thermal conditions in the atmosphere and at the surface of the sea. The material before me will not suffice to explain the proximate cause of the variation in temperature on the banks and in the depths of the fjords shown by the observations to have occurred there. Meanwhile, the positive result proves the existence of variations apparently unperiodical in character.

In the depths of the fjords and in the deep basins on the banks, we meet in greater depths, a vertically constant temperature. This is the same phenomenon observed in inland seas, e. g. the Mediterranean, the Banda Sea, the Sulu Sea. Were the constant deep-temperature mainly the result of atmospheric heat, it should most nearly correspond with the mean annual temperature of the air. For, both in winter and summer, the layers of water exposed to the direct action of the atmosphere remain uppermost, by reason of their inconsiderable amount of salt as compared to that of the deep, a distribution not affected in winter by the surface-temperature being lowest, and supported in summer by the higher temperature of the surface. The heat or cold is propagated downward by conduction only. Wholly different, however, may this relation prove during winter at a distance from land, where the surface-water is salter, since the latter, when cooled, may acquire a tendency to sink down into the warmer, and hence lighter, subjacent strata, thus propagating downward by convection the winter-cold throughout the deep. In such case, the atmospheric temperature of winter would exert a paramount effect on the temperature of the deep — as, for example, in the Mediterranean. The Skagerak Deep may, perhaps, in like manner be subject to the atmospheric temperature of winter.

If we compare the deep-temperatures in our fjords and other deep basins on the banks with the normal temperature of the air for the whole year, and for the winter-months (December, January and February), we shall obtain the general result given in the following Table. In this synopsis are comprised the deep-temperatures registered with the Miller-Casella thermometer that have shown a steady diminution of temperature with depth.[1]

[1] Petermanns Geographische Mittheilungen 1876; pp. 432, 433.

	Bredde. (*Latitude.*)	Dyb-Temp. (*Deep-Temp.*)	Lufttemperatur. (*Temperature of Air.*) Vinter. (*Winter.*)	Aar. (*Year.*)	Dyb over Vinter. (*Deep — Winter.*)	Dyb over Aar. (*Deep — Year.*)
Skagerak	58°.0	5°.0	0°.3	6°.0	4°.7	-1°.0
Bukken-Fjord	59 .2	5 .8	0 .7	6 .5	5 .1	-0 .7
Nærstrands-Fjord . .	59 .3	5 .6	-0 .1	6 .0	5 .7	-0 .4
Hardanger-Fjord.	60 .4	6 .4	-0 .4	6 .2	6 .8	0 .2
Aakre-Fjord	59 .8	6 .5	-0 .2	6 .2	6 .7	0 .3
Oster-Fjord	60 .6	6 .3	-0 .2	6 .5	6 .5	-0 .2
Sogne-Fjord	61 .2	6 .5	0 .7	6 .5	7 .2	0 .0
Nord-Fjord	61 .9	6 .6	0 .3	5 .8	6 .9	0 .8
Throndhjems-Fjord.	63 .5	6 .2	-1 .7	5 .4	7 .9	0 .8
Folden-Fjord	64 .7	7 .2	-0. 5	5 .2	7 .7	2 .0
Brønø	65 .5	6 .8	-0 .8	4 .9	7 .6	1 .9
W. for Vægø . . .	65 .6	6 .9	-0 .3	5 .2	7 .2	1 .7
Donnes-Fjord	66 .0	6 .0	-1 .2	4 .7	7 .2	1 .3
Ranen-Fjord	66 .2	4 .3	-3 .8	3 .5	8 .1	0 .8
Salten-Fjord	67 .2	3 .4	-3 .3	2 .9	6 .7	0 .5
Vest-Fjord	68 .2	6 .5	-2 .6	3 .4	9 .1	3 .1
Ofoten-Fjord	68 .4	6 .1	-3 .2	3 .0	9 .3	3 .1
Alten-Fjord	70 .1	4 .0	-7 .4	0 .5	11 .4	3 .5

Dybbassinernes Temperatur er højest udenfor Kysten omkring den 65. Breddegrad. Den er lavere i Fjordene og lavest i de mere continentale Ranen- og Salten-Fjord samt i den nordligt liggende Alten-Fjord. Overalt er Dyb-Temperaturen højere end Vinterens midlere Luft-Temperatur og Overskuddet stiger gjennemsnitlig med voxende Bredde. Dyb-Temperaturen er kun i og i Nærheden af Skagerak lavere end Luftens aarlige Middeltemperatur. Den mulige Aarsag hertil er ovenfor paapeget. Fra Sognefjorden til Nordkap er den højere, og Overskuddet voxer mod Nord.

De fundne Dybbassins-Temperaturer kunne saaledes ikke skyldes Luftens Temperatur. Det Vand, der befinder sig i Bassinerne, maa have faaet sin Temperatur fra andre Kilder, hvor Temperaturen er højere. Vi henvises til at søge disse i varmere, sydligere Egne.

Sammenstille vi Havoverfladens Temperatur med Luftens paa de Steder paa den norske Kyst, hvor begge ere maalte ved daglige Iagttagelser, faa vi følgende Tabel.

The temperature of the deep-basins is highest off the coast, about the 65th parallel of latitude. It is lower in the fjords, and lowest in those having a more continental character — the Ranen and Salten Fjords, and in the Alten-fjord, the most northerly. Everywhere, the deep-temperature is higher than the mean atmospheric temperature in winter; and the surplus is found to rise on an average with the latitude. The deep-temperature is lower only in and in close proximity to the Skagerak than the mean annual temperature of the air. The possible cause of this phenomenon has been pointed out above. From the Sognefjord to the North Cape it is higher, and the surplus increases towards the north.

The deep-basin temperatures observed cannot therefore be ascribed to the temperature of the air. The water in the basins must have got its temperature from other sources, where the heat is greater. These sources we shall have to seek in warmer, more southerly regions.

If we compare the temperature of the sea-surface with that of the air in those localities of the Norwegian coast where both are observed daily, we get the following Table.

Havoverfladens Temperatur minus Luftens Temperatur.
(*Temperature of Sea-Surface minus Temperature of Air.*)

	Jan.	Feb.	Mar.	Apr.	Maj	Juni	Juli	Aug.	Sept.	Oct.	Nov.	Dec.	Aar (*Year*)
Torungen	3°.0	2°.7	1°.8	0°.2	-0°.6	-0°.8	0°.1	1°.2	1°.9	3°.3	4°.2	3°.5	1°.7
Lindesnes	4 .0	3 .4	2 .4	1 .0	-0 .4	-0 .6	0 .3	0 .9	1 .5	3 .3	4 .3	4 .4	2 .0
Lister	2 .8	3 .5	2 .0	0 .8	-0 .4	-0 .1	0 .4	0 .6	0 .5	2 .3	3 .0	2 .9	1 .5
Udsire	3 .7	3 .3	2 .9	1 .5	-0 .6	-0 .5	1 .4	2 .0	2 .4	3 .4	4 .3	4 .1	2 .5
Hellisø	3 .6	3 .2	2 .5	0 .6	-0 .6	-0 .7	-0 .4	0 .3	1 .5	2 .8	4 .2	4 .1	1 .8
Ona	2 .9	2 .8	2 .2	1 .3	0 .3	-0 .2	0 .3	0 .6	1 .5	2 .7	3 .9	3 .2	1 .8
Prestø	2 .5	2 .8	1 .5	0 .7	0 .0	0 .0	0 .2	0 .0	0 .5	1 .5	2 .7	2 .6	1 .2
Andenes	2 .7	3 .3	3 .0	2 .1	1 .2	0 .3	0 .1	0 .0	0 .6	2 .0	2 .5	2 .4	1 .7
Gjesvær.	7 .0	4 .4	4 .1	2 .2	1 .5	0 .4	-1 .7	-3 .7	0 .6	2 .6	4 .1	4 .4	2 .2

I de fleste Maaneder er saaledes Havoverfladens Temperatur merkelig højere end Luftens, og i Gjennemsnit for Aaret henimod 2° (1°.8) højere. Havoverfladen modtager kun i et Par Vaar- og Sommer-Maaneder lidt Varme fra Luften, ellers giver den stadig Varme til Luften. Havets Temperatur i Overfladen hidrører saaledes væsentlig fra andre Kilder, ligesom Dybets.

Hence, during most months of the year the temperature of the sea-surface is considerably higher than that of the air, and the mean annual difference reaches close upon 2° (1°.8). During one or two of the summer-months only does the sea-surface get a trifling amount of heat from the atmosphere; the rest of the year it steadily continues giving off heat to the air. The temperature of the sea at the surface must, therefore, be chiefly derived from other sources, as is the case with that of the deep.

Isothermkarterne Pl. XVI og følgende vise, at Havets Temperatur langs Norges Kyst har sin Oprindelse fra Atlanterhavet, hvorfra Varmen forplantes ved Strømninger. Isothermernes Tungespidser eller Varmeaxerne vise os disse Strømningers Løb langs Norges Kyst.

The Maps of Isotherms, Pl. XVI and following, show the temperature of the sea along the coast of Norway to have its origin in the Atlantic, whence the heat is propagated by currents. The isothermal tongues, or axes of heat, exhibit these currents in their course along the coast of Norway.

7. Temperaturens aarlige Vandring i de øverste Lag.

7. Annual Variation of Temperature in the Upper Strata.

Den Maade, paa hvilken Temperaturen i Havet varierer i Aarets Løb i de øverste Lag indtil 100 Favnes Dybde, fortjener en nærmere Undersøgelse, da den frembyder flere merkelige Træk og er bestemmende for den midlere aarlige Fordeling af Temperaturen i disse Lag.

Sammenhængende Iagttagelser til at studere Temperaturens aarlige Gang i Dybet have vi fra Lødingen og fra Altenfjorden, som ovenfor nævnt (Side 87 og 88).

The manner wherein the temperature of the sea varies throughout the year in the upper strata down to a depth of 100 fathoms, deserves a closer investigation, presenting as it does various remarkable characteristics, and determining the distribution of the mean annual temperature in those strata.

Continuous observations for the study of the annual variation of the temperature in the deep, have been taken at Lødingen and in the Altenfjord, as stated above (pp. 87, 88).

Lødingen.

Dybde (Depth) Favne. (Fms.)	Meter.	Januar 1880	Januar 1881	Maj 1879	Maj 1880	Juni 1879	Juni 1880	Juli 1879	Juli 1880	August 1879	August 1880	September 1879	September 1880	October 1879	October 1880	November 1879	November 1880	December 1879	December 1880
		°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
0	0	3.0	2.1	4.1	5.4	6.9	7.1	11.4	10.1	12.7	11.8	10.7	10.5	9.3	7.0	6.9	3.7	5.0	4.4
10	18	3.8	2.7	3.8	4.9	6.2	6.6	9.5	8.9	10.5	10.8	10.6	10.5	9.5	7.7	7.4	4.3	5.4	2.8
20	37	4.0	3.2	3.5	4.5	5.4	5.8	6.9	7.2	8.1	8.7	10.5	10.1	9.8	8.2	7.6	5.5	5.7	3.7
30	55	4.4	4.4	3.9	4.6	5.2	5.3	5.8	5.8	6.4	7.2	9.6	7.0	9.9	7.9	7.7	7.3	5.9	5.3
40	73	4.9	5.1	4.7	5.2	5.4	5.2	5.9	5.4	6.0	5.8	8.8	6.0	10.2	7.0	7.8	7.4	6.4	6.4
50	92	5.3	5.7	5.6	5.5	5.7	5.3	6.1	5.6	6.0	6.0	8.4	6.0	10.2	6.4	7.5	6.7	6.4	6.5
70	130	6.4	6.3	6.2	6.0	6.1	5.9	6.3	6.2	6.2	6.1	7.8	6.2	8.1	6.0	7.1	6.2	6.6	6.2
100	188	6.4	6.3	6.4	6.4	6.3	6.3	6.6	6.5	6.5	6.4	6.3	6.4	6.3	6.3	6.4	6.4	6.3	6.3

Tages Middel af begge Rækker faaes:

Taking the mean of both series, we get —

Favne. (Fms.)	Meter.	Jan.	Maj.	Juni	Juli	Aug.	Sept.	Oct.	Nov.	Dec.	Aar (Year)	Var. (Range)
0	0	2°.6*	4°.8†	7°.0†	10°.8†	12°.3†	10°.6†	8°.2*	5°.3*	4°.7†	5°.9	9°.7
10	18	3.3	4.4	6.4	9.2	10.7	10.6	8.6	5.7	4.1*	5.8	7.4
20	37	3.6	4.0*	5.6	7.1	8.4	10.3	9.0†	6.6	4.7	5.5	6.7
30	55	4.4	4.3	5.3*	5.8	6.8	8.3	8.9	7.5	5.6	5.5	4.6
40	73	5.0	5.0	5.3	5.7*	5.9*	7.4	8.6	7.6†	6.4	5.6	3.6
50	92	5.5	5.6	5.5	5.9	6.0	7.2	8.3	7.1	6.5†	5.7	2.8
70	130	6.3	6.1	6.0	6.2	6.2	7.0	7.1	6.6	6.4	5.9	1.1
100	188	6.4†	6.4†	6.3†	6.5†	6.5†	6.4*	6.3*	6.4*	6.3*	6.4	0.2

Disse Temperaturrækker ere fremstillede grafisk i Pl. XXVI — Lødingen.

These serial temperatures are represented diagrammatically in Pl. XXVI — Lødingen.

I Januar er den laveste Temperatur i Overfladen, og Temperaturen stiger med Dybden, indtil den naar sit Maximum ved Bunden.

I de 4 følgende Maaneder har Overfladen et Maximum. Herfra aftager Temperaturen nedover til et Minimum, hvis Plads synker dybere og dybere, fra 20 Favne i Maj til 40 Favne i Juli og August. Fra dette Minimum af stiger Temperaturen nedover mod Bunden. I September er Maximum i Overfladen, og Temperaturen synker stadig nedover til Bunden, ganske modsat Forholdet i Januar. I de 3 følgende Maaneder har Overfladen (eller 10 Favnes Dyb i December) et Minimum; herfra voxer Temperaturen nedover til et Maximum, hvis Plads gaar nedover fra 20 Favne i October til 50 Favne i December. Fra dette Maximum af synker Temperaturen stadig til Bunden.

I Gjennemsnit for hele Aaret (Tallene for Januar regnede 3 Gange, og Summen divideret med 12) findes et Maximum i Overfladen, et Minimum i 30 Favnes Dyb og et Maximum ved Bunden, der er højere end Overfladens.

I samme Dyb er Temperaturen saaledes fordelt efter Aarstiden:

During January, the temperature is lowest at the surface, increasing with the depth, till it reaches its maximum at the bottom.

During the 4 following months, the surface exhibits a maximum. Thence the temperature falls to a minimum, the position of which sinks deeper and deeper, from 20 fathoms in May to 40 fathoms in July and August. From this minimum, the temperature rises towards the bottom. In September, the maximum is at the surface, and the temperature descends steadily to the bottom, a relation quite the reverse of that in January. In the following 3 months, the surface (or a depth of 10 fathoms in December) has a minimum, from which the temperature increases downwards to a maximum, its position ranging from 20 fathoms in October to 50 fathoms in December. From this maximum, the temperature sinks steadily to the bottom. On an average, for the whole year round (counting the figures for January 3 times, and dividing the sum by 12), a maximum is found at the surface, a minimum at a depth of 30 fathoms, and a maximum — higher than the surface-maximum — at the bottom.

At one and the same depth the temperature is distributed as follows, according to the time of year: —

Overfladen (*Surface*)	Minimum i Januar,	Maximum i August.
10 Favne (*Fms.*)	— - Januar,	— - August.
20 „	— - Januar,	— - September.
30 „	— - Maj,	— - October.
40 „	— - Jan. Maj,	— - October.
50 „	— - Jan. Juni,	— - October.
70 „	— - Juni,	— - October.
100 „	— - Juni, Oct. Dec.,	— - Juli, August.

I Dybet ere saaledes Vaarmaanederne koldest, og Høsten varmest. Temperaturens aarlige Variation aftager stadig i Størrelse fra $9^{0}.7$ i Overfladen til $0^{0}.2$ i 100 Favnes Dyb.

Thus, in the deep, the spring months are coldest, the autumn warmest. The annual range of temperature diminishes steadily, from $9^{0}.7$ at the surface to $0^{0}.2$ at a depth of 100 fathoms.

Alten-Fjord.

Dybde (*Depth*)		1883 Jan. 22.	1883 Febr. 24.	1883 Marts 24.	1883 April 21.	1883 Maj 22.	1883 Juni 19.	1883 Juli 17.	1883 August 14.	1883 Septbr. 5.	1882 Octbr. 12.	1882 Novbr. 21.	1882 Decbr. 19.	Aar (*Year*)	Var. (*Range*)
0 Fv.	0 m.	$1^{0}.6$*	$1^{0}.4$	$0^{0}.3$*	3.8†	$4^{0}.8$†	$11^{0}.9$†	$13^{0}.2$†	$10^{0}.0$†	$8^{0}.4$†	$6^{0}.9$*	$6^{0}.2$*	$3^{0}.9$	$6^{0}.0$†	$12^{0}.9$
5	9	2.1	1.4	0.7	3.0*	3.5	6.9	6.1	7.3	7.2	8.0	6.3	3.5	4.6	7.3
10	18	2.1	1.3*	1.0	3.1	3.4*	5.6	5.2	5.3	6.8	8.6	6.3	3.3*	4.2	7.6
20	37	2.1	1.8	1.1	3.1	3.5	4.5	4.5	4.8	5.0	9.2	6.3	4.0	4.2*	8.1
30	55	2.2	2.0	1.5	3.2	3.9	4.1	4.4	4.5	4.8	9.2†	6.3	4.2	4.2	7.7
40	73	2.2	2.1	1.9	3.6	4.1	3.8	4.1	4.2	4.5*	9.1	6.3	4.2	4.2	7.2
50	91	2.3	2.1	2.1	4.0	4.1	3.8*	3.9*	4.1*	4.6	8.6	6.3	4.1	4.2*	6.5
60	110	3.1	2.4	4.1	4.1	4.2	3.8	4.1	4.3	4.6	7.3	6.4	4.1	4.4	4.9
70	128	3.9	3.1	4.2	4.3	4.6	4.1	4.6	4.6	4.7	6.0	6.6†	4.1	4.6	3.5
80	146	4.1	3.7	5.0	4.7	4.9	4.4	4.9	4.8	4.8	5.0	6.1	4.2	4.7	2.4
90	165	4.2	4.1	5.0	5.0	5.2	4.7	5.0	5.0	4.9	4.7	5.7	5.0	4.9	1.6
100	183	4.5†	4.5†	5.1†	5.2†	5.2†	4.8†	5.1†	5.0†	4.9†	4.5*	5.1*	5.0†	4.9†	0.7

I Januar er den laveste Temperatur i Overfladen, den højeste ved Bunden i 100 Favnes Dyb. I Februar og Marts væsentlig det samme. I April begynder Minimum at rykke

In January, the lowest temperature occurs at the surface, the highest at the bottom at a depth of 100 fathoms. In February and March, the distribution is essentially the

nedover, idet Overfladen begynder at opvarmes. Ved Bunden er et Maximum helt til October. I Maj er Minimum i 10 Favne, i Juni, Juli og August i 50 Favnes Dyb. Fra Juni til September er Overfladen varmest. I September er Minimum løftet til 40 Favne. I October er der Minima i Overfladen og ved Bunden, medens Maximum er i 30 til 40 Favnes Dyb, og de dybere Lag ere merkelig varmere end i den foregaaende Maaned. Dette Forhold, der ogsaa fandt Sted ved Lødingen i October 1879, er neppe det normale, da det paa sidstnævnte Sted ikke gjenfindes i October 1880, i hvilket Aar November fik den højeste Varmegrad i de dybere Lag. I November er der i Altenfjord Minima i Overfladen og ved Bunden, Maximum i 70 Favne. I December falder Minimum i 10 Favne og Maximum ved Bunden.

I Gjennemsnit for hele Aaret finde vi et Maximum i Overfladen, et Minimum fra 10 til 50 Favnes Dyb og et mindre Maximum i 100 Favnes Dyb.

same. In April, the minimum begins to pass downwards, the surface at that season of the year beginning to get heated. At the bottom, a maximum continues as late as October. In May, there is a minimum 10 fathoms deep, in June, July, and August, at a depth of 50 fathoms. From June to September, the surface continues warmest. In September, the minimum has risen to 40 fathoms. In October, minima occur at the surface and at the bottom, whereas the maximum occurs at a depth of from 30 to 40 fathoms; and the deeper strata are appreciably warmer than during the preceding month. This relation, also found to occur at Lødingen in October 1879, can hardly be normal, not having been met with there in October 1880; that year, November had the highest temperature throughout the deeper strata. In November, minima occur in the Altenfjord, at the surface and at the bottom, and a maximum in 70 fathoms. In December, the minimum is found in 10 fathoms, the maximum at the bottom.

For the whole year, we have on an average a maximum at the surface, a minimum at a depth of 10 to 50 fathoms, and a lesser maximum at a depth of 100 fathoms.

I Overfladen er (*At the Surface*)	Minimum i Marts,	Maximum i Juli.
„ 5 Favne „	— - Marts,	— - October.
„ 10 (*Fms.*) „	— - Marts,	— - October.
„ 20 „ „	— - Marts,	— - October.
„ 30 „ „	— - Marts,	— - October.
„ 40 „ „	— - Marts,	— - October.
„ 50 „ „	— - Marts,	— - October.
„ 60 „ „	— - Februar,	— - October.
„ 70 „ „	— - Februar,	— - November.
„ 80 „ „	— - Februar,	— - November.
„ 90 „ „	— - Februar,	— - November.
„ 100 „ „	— - Jan., Feb., Oct.,	— - April, Maj.

Den aarlige Variation har et Maximum i Overfladen, et secundært Minimum i 5 Favne, et secundært Maximum i 20 Favne og aftager herfra regelmæssig mod Bunden, idet den i 100 Favnes Dyb gaar ned til 0°.7.

Saavel ved Lødingen som i Alten-Fjorden foregaar saaledes Havtemperaturens aarlige Vandring paa den ejendommelige Maade, at Temperaturen i Begyndelsen af Aaret er lavest i Overfladen og voxer stadig til 100 Favnes Dybde, hvor den hele Aaret igjennem er lidet foranderlig. Fra April af og til Høsten er Temperaturen i de dybere Lag over 100 Favne fremdeles stigende med Dybden, medens den i de øvre Lag aftager med Dybden, idet Overfladen bliver varmere og varmere. Der opstaar saaledes i et vist Dyb et Minimum af Temperatur, der om Vaaren ligger højere oppe og om Sommeren dybere nede. Om Høsten, i September eller October, vil Temperaturen kunne være langsomt og stadigt aftagende fra Overfladen til Bunden. Derpaa følger en Periode, i hvilken Overfladen stadig afkjøles, og det raskere end de underliggende øvre Lag, og Tempeturen i disse bliver voxende med Dybden, medens den i de dybere Lag fremdeles er aftagende. Man faar et Maximum af Temperatur i en vis Dybde mellem Overfladen og 100

The annual range exhibits a maximum at the surface, a secondary minimum in 5 fathoms, a secondary maximum in 20 fathoms, and diminishes from thence gradually to the bottom, sinking at a depth of 100 fathoms to 0°.7.

Both at Lødingen and in the Altenfjord, the annual variation of the sea-temperature proceeds in the singular manner, that the temperature, at the outset of the year, is lowest at the surface, increasing steadily to a depth of 100 fathoms, where it is well-nigh constant all the year round. From April to autumn, the temperature in the deeper strata, above 100 fathoms, is still found to rise with the depth, whereas in the upper strata it diminishes with the depth, the surface becoming warmer and warmer. Hence, at a certain depth we get a minimum of temperature, which in spring lies higher up and in summer deeper down. In autumn, during the months of September or October, the temperature will possibly be found to fall slowly and steadily from the surface to the bottom. Then follows a period during which the surface becomes steadily cooled, and with greater rapidity than is the case with the subjacent upper strata; accordingly the temperature throughout the latter increases with the depth, while that in the

Favne. Ved fortsat Afkjøling ovenfra bringes dette Maximum efterhaanden nedover, indtil det naar Bunden, og Temperaturen i Januar aftager stadig ovenfra nedad.

deeper strata still continues to diminish. A maximum of temperature is attained at a certain depth, between the surface and 100 fathoms. Continuous cooling from above gradually brings down this maximum till it reaches the bottom, and till the temperature in January steadily decreases from above downwards.

At Temperaturens aarlige Vandring foregaar paa denne Maade paa andre Steder end ved Lødingen og i Alten-Fjorden, fremgaar af talrige Iagttagelser. Kjendemerkerne ere de ovenfor fremhævede: Et Minimum mellem Overfladen og 100 Favnes Dyb om Vaaren og Sommeren, et Maximum samme Steds om Høsten, stadig voxende Temperatur med Dybden om Vinteren. En stadig aftagende Temperatur med Dybden ved Høstjevndøgnstider kan ikke opstilles som Kjendemerke, da en saadan Fordeling af Temperaturen paa mange Steder, nemlig i det aabne Hav, er den almindelige i de fleste Maaneder af Aaret.

That the annual variation of the temperature proceeds in the manner described above in other places than Lødingen and the Altenfjord, is evident from numerous observations. The chief characteristics are those already set forth, viz: — A minimum in spring and summer between the surface and a depth of 100 fathoms; a maximum in the same place during autumn; temperature steadily increasing with depth throughout the winter. A temperature steadily diminishing with depth at the autumnal equinox cannot be taken as a trustworthy characteristic, since the latter distribution of the temperature, in many localities, viz., the open sea, for example, prevails during the greater part of the year.

Et Minimum af Temperatur i Dybden mellem Overfladen og 100 Favne er observeret paa følgende Stationer (Se Pl. III til VIII):

A minimum of temperature in depths between the surface and 100 fathoms, was observed at the following Stations (See Pls. III to VIII): —

Station No.	Dybde af Min. (*Depth of Min.*)	Maaned (*Month*)	Sted (*Locality*)
24	55 Fv.	Juni	Udenfor (*off*) Romsdal.
40	50	Juli	N. for Færøerne.
93	72	Aug.	Romsdalsfjord.
94	20	Juni	Udenfor (*off*) Udsire.
95	50	Juni	— „ Bergen.
107	30	Juni	— „ Vigten.
148	60	Juni	Vestfjorden.
155	50	Juni	Ved (*at*) Røst.
172	20	Juli	„ „ Andenes.
176	50	Juli	„ „ —
217	30	Juli	„ „ Jan Mayen.
221	30	Juli	„ „ —
223	30	Aug.	„ „ —
231	40	Aug.	„ „ —
237	40	Aug.	„ „ —
238	60	Aug.	„ „ —
240	50	Aug.	„ „ —
253	100	Aug.	Skjersta-Fjord.
254	60	Aug.	Vest-Fjorden.
255	40	Juni	—
256	100	Juni	Alten-Fjord.
259	40	Juni	Porsanger-Fjord.
297	50	Juli	Grønlandshavet (*Grld. Sea*).
298	50	Juli	—
300	40	Juli	—
302	40	Juli	—
304	25 Fv.	Juli	Grønlandshavet (*Grld. Sea*).
325	50	Juli	Ved (*at*) Beeren-Eiland.
338	20	Aug.	Spidsbergen.
348	40	Aug.	Grønlandshavet (*Grld. Sea*).
350	40	Aug.	—
351	40	Aug.	—
352	40	Aug.	—
353	40	Aug.	—
356	40	Aug.	Spidsbergen.
357	60	Aug.	—
370	20	Aug.	—
373	40	Aug.	—
D. 22	10	Juni	Island.
D. 30	40	Juli	—
D. 31	34	Juli	—
H. 2	50	Maj	Skagerak.
H. 4	30	Sept.	Throndhjemsfjord.
H. 7	30	Juli	Folden-Fjord.
H. 8	40	Aug.	—
H. 11	50	Juli	Udenfor (*off*) Folden-Fjord.
H. 19	61	Juli	„ Brønø.
H. 26	55	Aug.	Fiskebank (*bank*).
H. 27	82	Juli.	Dønnes-Fjord.

Man ser, at alle de Steder, hvor det nævnte Temperatur-Minimum er observeret, ligge enten ved Kysterne af Island, Færøerne, Norge, Beeren-Eiland, Spidsbergen og Jan Mayen eller i Grønlandshavet paa den Strækning, der om Vinteren er dækket af Is og om Sommeren isfri. I det aabne Hav er saagodtsom overalt Temperaturen om Sommeren funden aftagende med Dybden.

Hence it appears, that all the localities in which the said temperature-minimum has been met with, lie either off the coasts of Iceland, the Færoes, Norway, Beeren-Eiland, Spitzbergen, and Jan Mayen, or in the Greenland Sea, viz., throughout the tract covered with ice during winter and free from ice in summer. In the open sea, the temperature in summer is almost everywhere found to diminish with the depth.

Temperaturens Tilvæxt med Dybden i Vintermaanederne sees af følgende Observationer:

The increase of temperature with depth during the winter-months, will be seen from the following observations: —

Capt. Carsten Bruun.
1871. Februar 27.
58° 3′ N. Br. 8° 0′ E. Lgd.
Skagerak.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. Mill.-Cas.
0	0	4°.5
50	91	5 .8
100	183	6 .7
150	274	6 .9

C. Bruun.
1871. Marts 1.
58° 22′ N. Br. 6° 1′ E. Lgd.
Lister.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. Mill.-Cas.
0	0	2°.5
50	91	5 .5
100	183	6 .3
150	274	6 .4

O. Jensen.
1880. Marts 3.
$^1/_2$ Mil Nord for Udsire.
(*2 Miles N of Udsire.*)

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	4°.1
34	62	5 .2
65	119	6 .4
72	132	6 .6

O. Jensen.
1880. Marts 5.
1 Mil Nord for Udsire.
(*4 Miles N of Udsire.*)

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	4°.2
103	189	6 .9

O. Jensen.
1881. Marts 8.
1 Mil N. W. af Rovær.
(*4 Miles NW of Rovær.*)

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	1°.8
21	38	1 .9
41	75	2 .8
62	113	4 .0
82	150	5 .5
103	188	6 .4

E. Sæther.
1881. Marts 5.
3 Mil af Romsdalskysten.
(*12 Miles off the Coast of Romsdal.*)

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	2°.9
20	37	3 .0
50	91	3 .1

Capt. C. Knap.
1884. Marts 17.
Raftsundet.
Lofoten.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	2°.9
10	18	3 .3
20	37	3 .6
30	55	3 .8
40	73	4 .3
50	91	5 .3
60	110	5 .7
70	128	5 .8
80	146	5 .9
90	165	6 .3

Disse Exempler ere et Udvalg af længere Observationsrækker, blandt hvilke især fremhæves de af Cand. Olaf Jensen paa Sildefisket (nordenfor Stavanger), de under Vaartorskefisket udenfor Aalesund af Capt. Nielsen og Rector Voss, og de ved Lofoten ved Opsynscheferne Capt. Juel og Capt. Knap. Fra Grønlandshavet haves følgende Observationer af norske Sælfangere.

These examples have been selected from an extensive series of observations, amongst which deserve special mention those of Mr. Olaf Jensen, taken on the herring-fishery (north of Stavanger); those made during the spring cod-fishery off Aalesund by Capt. Nielsen and Rector Voss; and those taken at Lofoten by Capt. Juel and Capt. Knap, Government Inspectors of that fishery. From the Greenland Sea, we have the following observations, by Norwegian sealers.

C. Bruun.
1878. Marts 26.
72° 12′ N. Br. 1° 0′ E. Lgd.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	-1°.9
20	37	-1 .4
30	55	-2 .0
40	73	-2 .0
50	91	-0 .6
60	110	0 .7
70	128	0 .6
80	146	0 .6
90	165	0 .5
100	183	0 .4
120	219	0 .3
140	256	0 .3
160	293	0 .1

C. Bruun.
1878. April 17.
73° 40′ N. Br. 1° 32′ E. Lgd.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	-2°.0
10	18	-1 .9
20	37	-1 .9
30	55	-1 .9
40	73	-1 .9
50	91	-1 .9
60	110	-1 .8
70	128	-1 .7
80	146	-1 .4
90	165	-0 .9
100	183	-0 .7
110	201	-0 .5
120	219	-0 .5

F. Nansen.
1882. Marts 28.
74° 55′ N. Br. 4° 35′ E. Lgd.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	-1°.7
10	18	-1 .5
20	37	-1 .7
30	55	-1 .4
50	91	-1 .1

F. Nansen.
1882. April 24.
73° 10′ N. Br. 11° 10′ E. Lgd.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp. N. & Z.
0	0	-2°.1
20	37	-2 .0
40	73	-1 .5
60	110	0 .2
80	146	0 .3
100	183	1 .6

Disse Observationer ere tagne paa Steder, hvor der var Drivis. Et Maximum af Temperatur om Høsten i mindre Dybder antydes. af de Observationer, Cand. Wallem gjorde med et Negretti- & Zambra's Vendethermometer i 1884 i Egnen omkring Bodo, i Senjen, Malangen og Eidsfjorden. Indtil de ringe Dybder, paa hvilke Cand. Wallem observerede, var Temperaturen i Regelen voxende med Dybden. I de følgende Tilfælder kommer Maximum frem i ringere Dybde.

These observations were taken in localities encumbered with drift-ice. A maximum of temperature in autumn at comparatively inconsiderable depths, is shown to occur from the observations of Mr. Wallem, with a Negretti & Zambra inverting-thermometer, 1884, round Bodø, in Senjen, Malangen, and the Eidsfjord. Down to the trifling depths at which Mr. Wallem extended his observations, the temperature was found as a rule to increase with the depth. In the following cases, a maximum is met with in lesser depths.

1884. Oct. 3.
Bakkeby.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp.
0	0	9°.9
5	9	10 .0
10	18	9 .8
16	29	9 .4

1884. Oct. 10.
Sildpollen.

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temp.
0	0	9°.9
10	18	10 .8
18	33	10 .3

NE Vind, fra Land.
(*Wind NE from Land.*)

Vi have seet, at ved Lodingen og i Altenfjorden viser Aarets Middeltemperatur i Havet et Maximum ved Overfladen og et Minimum mellem 30 og 50 Favne. For at komme til Kundskab om, hvorledes det forholder sig i denne Henseende i Gronlandshavet, har jeg taget Medium af Capt. C. Bruun's Temperaturrækker fra Marts og April 1878 og sammenstillet dette med vor Temperaturrække fra Juli 1878 No. 298. Middelet af Vinterrækken og Sommerrækken vil give en tilnærmet Værdi for Aarets Middeltemperatur i de forskjellige Dybder. Resultatet heraf sees af den følgende Tabel.

We have seen that at Lodingen and in the Altenfjord the annual mean temperature of the sea exhibits a maximum at the surface and a minimum between 30 and 50 fathoms. With a view to ascertain the law of distribution in the Greenland Sea, I took the mean of Capt. C. Bruun's serial temperatures from March and April 1878, comparing it with our serial temperatures from July 1878, No. 298. The mean of the winter-series and of the summer-series will give an approximate value for the annual mean temperature of the sea in the different depths. The result is shown by the following Table: —

Dybde (*Depth*) Favne. (*Fms.*)	Meter.	Temperatur (*Temperature*) April 6. 72° 56′ N. Br. 1° 16′ E. Lgd.	Juli 17. 72° 52′ 1° 51′	Aar. (*Year.*) 72° 54′ 1° 33′	Aarlig Var. (*Range.*)
0	0	-2°.0	4°.0	1°.0	6°.0
20	37	-1 .7	2 .3	0 .3	4 .0
30	55	-2 .0	-0 .1	-1 .0	1 .9
40	73	-2 .0	-0 .8	-1 .3*	1 .2
50	91	-1 .3	-1 .2	-1 .2	0 .1
60	110	-0 .6	-1 .1	-0 .8	0 .5
80	146	-0 .4	-0 .4	-0 .4	0 .0
100	183	-0 .2	0 .0	-0 .1	0 .2
120	219	-0 .1	0 .0	0 .0	0 .1

Man faar ogsaa her et Maximum i Overfladen og et Minimum i 40 Favnes Dyb i den aarlige Middeltemperatur. Herefter er Temperaturens Fordeling for Aaret i de øverste 100 Favne construeret i Temperaturcurven No. 298, Pl. VI og i Tversnittet XVII, Pl. XII ved denne Station.

Here, too, we have a maximum at the surface, and a minimum at the depth of 40 fathoms, in the annual mean temperature. From these data, the annual distribution of temperature in the upper 100 fathoms has been marked off in the curve of temperature No. 298, Pl. VI, and in the transverse section XVII, Pl. XII, at that Station.

Ved Kysten er om Vinteren Temperaturen i Havet lavest ved Land og voxer saavel udover mod Søen som

Off the coast, the temperature of the sea in winter is lowest inshore, augmenting alike seaward and down-

nedover mod Dybet. Dette vises blandt andet af følgende Observationsrækker fra Svolvær i Lofoten, tagne i den sidste Uge af Januar 1878 ved Opsynschefen, Capt. Juel's Foranstaltning. Stationerne I til IV følge efter hverandre fra Land af udover Søen.

ward. This appears, *inter alia,* from the following series of observations, taken at Svolvær in Lofoten during the last week of January 1878, by order of Capt. Juel, Govnt. Inspector of the Lofoten cod-fishery. Stations I o IV follow in succession from the land, seaward.

Station	I	II	III	IV	Station
Bundens Dybde i Favne	5	10	25	70	Depth of Bottom in Fathoms
Temperatur i 0 Favnes Dyb	1°.4	2°.2	2°.7	2°.7	Temperature at Depth of 0 Fathoms
5	1.5				5
10		2.5	2.9	3.0	10
25			3.8	3.5	25
35				4.5	35
40				5.4	40
45				6.1	45
50				6.4	50
60				6.7	60
70				6.7	70

Isothermobatherne ligge, i et Verticalsnit, paa skraa, og Normalen paa dem, trukket fra højere til lavere Temperaturer, peger opad og mod Land. Da Luftens Temperatur paa denne Aarstid er lavere end Havoverfladens og lavere over Land end over Havet, henvises vi til Kulden over Landet som Aarsag til Temperaturens ejendommelige Fordeling i Havet under Kysten om Vinteren.

At denne Afkjøling fra oven væsentlig foregaar ved Ledning og ikke ved nedgaaende Strømninger af afkjølet Vand, sees af følgende Exempel. Expeditionens Chemiker, Hr. Svendsen, observerede i Juni 1876 ved Husø[1], Mundingen af Sognefjorden, en specifisk Vægt ved $\frac{17^0.5}{17^0.5}$ i Overfladen lig 1.02465, i 11 Favnes Dyb lig 1.02492. Sættes Overfladens Temperatur i Marts til 4°.5, og antages den, efter Observationerne fra Svolvær, at voxe med 0°.3 til 10 Favnes Dyb, faar man for Marts, den koldeste Maaned, i Overfladen en specifisk Vægt af 1.02567, i 11 Favnes Dyb af 1.02590. Den større Saltholdighed i Dybet bevirker altsaa, at Overfladens ferskere Vand, selv med dets lavere Vintertemperatur, ikke faar nogen Tendents til at synke. Sml. S. 89.

Efter de foreliggende Iagttagelser er den aarlige Variation af Havets Temperatur størst i Overfladen, aftager stadigt med Dybden og forsvinder i 100 Favnes Dyb eller lidt dybere.

The isothermobaths lie, in a vertical section, obliquely, and their normal, drawn from higher to lower temperatures, points upward, and towards land. The temperature of the air at that season of the year being lower than the temperature of the sea-surface, and lower over the land than over the sea, we must obviously seek in the cold over the land for the cause of so remarkable a distribution of the sea's temperature on the coast during winter.

That such cooling from above is principally brought about by conduction, and not by descending currents of cooled water, may be seen from the following observation. Mr. Svendsen, chemist to the Expedition, found in June 1876, at Huso,[1] off the mouth of the Sognefjord, a specific gravity, reduced to $\frac{17^0.5}{17^0.5}$, equal at the surface of the sea to 1.02465, at a depth of 11 fathoms to 1.02492. Now, putting the surface-temperature in March at 4°.5, and assuming it, from the observations taken at Svolvær, to increase 0°.3 down to a depth of 10 fathoms, we shall get for March, the coldest month, at the surface a specific gravity of 1.02567, at a depth of 11 fathoms of 1.02590. The greater proportion of salt in the deep is attended therefore with the effect, that the comparatively fresh water of the surface, even with its lower winter-temperature, has no tendency to sink (See p. 89).

From the observations given above, it follows that the annual range of the sea's temperature is greatest at the surface, diminishing steadily with the depth, and ceasing altogether at a depth of 100 fathoms, or a trifle deeper.

8. Temperaturens aarlige Variation i Havets Overflade.

For at studere Temperaturens Variation i Havets Overflade har jeg udarbejdet nye Karter over samme for Maanederne August og Marts. Jeg har valgt disse Maa-

8. Annual Variation of Temperature at the Surface of the Sea.

With a view to study the variation of temperature at the surface of the sea, I have constructed new maps for the months of August and March. These months I selected,

[1] Tornøe, Chemi, III, S. 59. No. 14—19.

[1] Tornoe, Chemistry, III, p. 59. No. 14—19.

neder som dem, der gjennemsnitlig frembyde Aarets højeste og laveste Temperatur i den normale aarlige Periode. Det Materiale, jeg hertil har benyttet, er dels Observationer fra faste Kyststationer, dels saadanne, der ere udførte paa Havet selv ved forskjellige Expeditioner eller Handelsfartøjer.

Den følgende Tabel giver Resultatet af Iagttagelserne fra Kyst-Stationerne. Paa samtlige disse viser August den højeste Varmegrad. Paa de faa Steder, hvor Februar og og ikke Marts har den laveste Temperatur, afviger denne saa lidet fra Marts-Temperaturen, der er opført i Tabellen, at Forskjellen er uden Betydning for vort Øjemed.

Iagttagelserne fra de norske Stationer ere det norske meteorologiske Instituts, under hvis Ledelse de ere udførte og hvor de ere bearbejdede.

Iagttagelserne fra de skotske Stationer ere de af A. Buchan meddelte i Journal of the Scottish Meteorological Society Vol. III, April 1871, S. 153. De ere samtlige reducerede til den 14aarlige Række 1857—71.

Iagttagelserne fra de danske Stationer ere hentede fra Meteorologisk Aarbog, udgivet af det danske meteorologiske Institut, fra 1875—83.

Iagttagelserne fra Jan Mayen ere fra den østerrigske Polarstation. Bericht etc. v. E. v. Wohlgemuth.

embracing generally as they do the highest and lowest temperature of the year during the normal annual period. The material made use of for this purpose consists partly of observations from Coast-Stations, partly of such as were taken at sea on various Expeditions or by captains of merchant vessels.

The following Table gives the result from the Coastal Stations. At all such, the month of August exhibits the highest temperature. In the few localities where February and not March has the lowest temperature, this deviates to so trifling an extent from the temperature of March, as given in the Table, that the difference is absolutely without effect on the question at issue.

The observations from the Norwegian Coastal Stations were taken under the immediate supervision of, as also worked up at, the Norwegian Meteorological Institute.

The observations from the Scottish Stations are those communicated by Mr. A. Buchan in "Journal of the Scottish Meteorological Society," Vol. III, April 1871, p. 153. They have all been reduced to the 14 years 1857—71.

The observations from the Danish Stations are derived from "Meteorologisk Aarbog," published by the Danish Meteorological Institute, from 1875 to 1883.

The observations from Jan Mayen were taken at the Austrian Polar Station. "Bericht," etc., v. E. v. Wohlgemuth.

				Temperatur.			
Station.	Bredde. (*Latitude.*)	Længde. (*Longitude.*)	Aar. (*Years.*)	Marts. (*March.*)	Aug. (*Augt.*)	Aar. (*Year.*)	Var. (*Range.*)
	° ′	° ′		°	°	°	°
Torungen	58 25 N.	8 48 E.	1867—82	1.7	16.6	8.2	14.9
Lindesnes	57 59	7 3 E.	67—75	3.1	15.7	8.7	12.6
Lister	58 7	6 34 E.	67—77	3.0	15.3	8.3	12.3
Udsire	59 18	4 53 E.	67—82	4.2	15.4	9.0	11.2
Hellisø	60 45	4 43 E.	67—82	4.5	13.9	8.7	9.4
Ona	62 52	6 33 E.	68—82	4.0	13.0	8.0	9.0
Prestø	64 47	11 7 E.	72—82	2.0	12.9	6.6	10.9
Reine	67 56	13 9 E.	69—71	3.0	12.1	6.1	9.1
Andenes	69 20	16 18 E.	67—82	0.7	11.1	4.9	10.4
Fruholm	71 6	23 59 E.	68—75	-2.4	8.5	5.0	6.1
Vardø	70 22	31 8 E.	78—79	1.4	6.1	4.3	4.7
East Yell	60 33	1 3 W.	1858—69	7.2	12.2	9.4	5.0
Bressa	60 6	1 8 W.	57—58	6.1	12.0	8.9	5.9
Sandwick	59 2	3 18 W.	57—71	6.7	12.9	9.3	6.2
Stornoway	58 11	6 22 W.	57—71	7.2	13.6	9.4	6.4
Bernera	58 13	6 53 W.	59—70	6.6	13.2	9.4	6.6
Harris	57 50	6 50 W.	58—63	6.3	13.1	9.4	6.8
Oban	56 25	5 30 W.	59—65	6.3	13.2	9.6	6.9
Otter House	56 0	5 19 W.	58—67	6.7	12.9	9.6	6.2
Westhaven	56 53	2 12 W.	57—71	5.1	14.6	9.3	9.5
North Berwick	56 3	2 43 W.	57—61	4.6	13.6	8.9	9.0
Dunbar	56 0	2 30 W.	57—64	4.1	13.3	8.7	9.2
Trinity Chain Pier	55 58	3 24 W.	64—67	4.0	13.6	8.8	9.6
Horns Rev	55 34	7 19 E.	1879—83	2.0	16.1	8.7	14.1
Skagens Rev	57 46	10 43 E.	79—83	3.5	16.9	8.7	13.4
Thorshavn	62 2	6 44 W.	75—82	5.4	10.8	7.9	5.4
Papey	64 40	14 15 W.	75—82	0.7	6.8	3.3	6.1
Grimsey	66 34	18 3 W.	75—81	1.4	8.1	4.6	6.7
Stykkisholm	65 5	22 46 W.	75—82	1.1	10.9	5.3	9.8
Jan Mayen	70 59	8 28 W.	1882—83	-1.6	2.8	0.0	4.4

De Observationer, jeg har benyttet til Kartet for August, hidrøre dels fra norske Skibe, navnlig Arkhangelskfarere og Nordsøfarere, dels fra følgende videnskabelige Expeditioner, Fangstfarter eller Orlogstogter. Gaimard, "La Recherche", 1838 og 1839 Nordsøen-Spidsbergen, 1840 Island-Hammerfest-Arkhangelsk. Lord Dufferin, 1856, Island-Jan Mayen-Hammerfest-Spidsbergen. Koldewey, "Germania" 1868, Grønlandshavet, Østhavet. Nordenskiöld og Palander, "Sofia" 1868, Grønlandshavet og Østhavet. Dorst, "Bienenkorb" 1869, Grønlandshavet. Bessels, "Albert" 1869, Østhavet. Koldewey, "Germania" 1869 og 1870, Nordsøen-Jan Mayen-Grønland. Lamont, "Diana" 1871, Grønlandshavet. Weyprecht, "Isbjørn" 1871, Østhavet. Tobiesen, "Freia" 1871, Østhavet. Melsom, "Germania" 1871, Østhavet. Den norske Nordhavs-Expedition, "Vøringen", 1876 Norge-Island, 1877 Norge-Jan Mayen, 1878 Spidsbergen, Grønlandshavet. Nordenskiöld og Palander, "Vega" 1878, Østhavet. "Fylla" 1877 og 1878, Island. "Ingolf" 1879, Island og Danmarkstrædet. "W. Barents" 1878 og 1879, Østhavet. Nordenskiöld, "Sofia" 1883, Danmarkstrædet. Sorensen, "William" 1885, Island-Norge. Admiral Irminger, Tidsskrift for Søvæsen 1861, Pl. I, flere danske Orlogstogter, Øst-Island-Færøerne.

Foruden Observationer fra August har jeg ogsaa benyttet saadanne for Juli og for September og har reduceret samtlige til Midten af August paa følgende Maade. For Stationerne Fruholm og Jan Mayen optegnedes Curven for Temperaturens aarlige Gang efter Maanedsmedia, og Curven for den sidste Station, der var mindre regelmæssig, udjevnedes paa grafisk Vej. Efter disse Curver fandtes følgende Afvigelser mellem Temperaturen den 15. August og de respective Dage.

The observations I have made use of for the August Map, are derived in part from Norwegian merchant vessels, chiefly those trading on Archangel and those navigating the North Sea, and in part from the following scientific Expeditions, as also from sealers or from men of war, viz: — Gaimard, "La Recherche," 1838 and 1839 North Sea-Spitzbergen, 1840 Iceland-Hammerfest-Archangel; Lord Dufferin, 1856, Iceland-Jan Mayen-Hammerfest-Spitzbergen; Koldewey, "Germania," 1868, Greenland Sea, Barents Sea; Nordenskiöld and Palander, "Sofia," 1868, Greenland Sea and Barents Sea; Dorst, "Bienenkorb," 1869, Greenland Sea; Bessels, "Albert," 1869, Barents Sea; Koldewey, "Germania," 1869 and 1870, North Sea-Jan Mayen-Greenland; Lamont, "Diana," 1871, Greenland Sea; Weyprecht, "Isbjørn," 1871, Barents Sea; Tobiesen, "Freia," 1871, Barents Sea; Melsom, "Germania," 1871, Barents Sea; The Norwegian North-Atlantic Expedition, "Vøringen," 1876, Norway-Iceland, 1877, Norway-Jan Mayen, 1878, Spitzbergen, Greenland Sea; Nordenskiöld and Palander, "Vega," 1878, Barents Sea; "Fylla," 1877 and 1878, Iceland; "Ingolf," 1879, Iceland and Denmark Strait; "W. Barents," 1878 and 1879, Barents Sea; Nordenskiöld, "Sofia," 1883, Denmark Strait; Sørensen, "William," 1885, Iceland-Norway; Admiral Irminger, Tidsskrift for Søvæsen, 1861, Pl. I, several Danish men-of-war cruises, East Iceland-Færoes.

Besides observations in August, I have also made use of other such, taken in July and in September, reducing them all to the middle of August, in the following manner. For the Stations Fruholm and Jan Mayen, I constructed a curve showing the annual variation of temperature by monthly means, the observations for the latter Station, which did not show so regular a course, having been smoothed off by a freehand curve. From these curves were found the following *differences* between the temperature on the 15th of August and the days heading the columns of the Table.

Juli (*July*)	1	5	10	15	20	25	30
Fruholm	1°.5	1°.2	0°.9	0°.6	0°.4	0°.3	0°.2
Jan Mayen	1 .7	1 .4	1 .1	0 .8	0 .6	0 .4	0 .2
Middel (*Mean*)	1 .6	1 .3	1 .0	0 .7	0 .5	0 .4	0 .2
August	5	10	15	20	25	30	
Fruholm	0 .1	0 .0	0 .0	0 .0	0 .1	0 .2	
Jan Mayen	0 .1	0 .0	0 .0	0 .0	0 .1	0 .2	
Middel (*Mean*)	0 .1	0 .0	0 .0	0 .0	0 .1	0 .2	
September	5	10	15	20	25	30	
Fruholm	0 .4	0 .5	0 .7	1 .0	1 .2	1 .5	
Jan Mayen	0 .4	0 .7	0 .9	1 .0	1 .3	1 .5	
Middel (*Mean*)	0 .4	0 .6	0 .8	1 .0	1 .2	1 .5	

Af de som Middel anførte Tal for hver femte Dag construeredes ved Interpolation en Tabel, der for hver Dag fra 1. Juli til 30. September giver den Størrelse, der, tillagt en paa den tilsvarende Dag gjort Observation, reducerer denne til den 15. August.

De saaledes reducerede Observationer afsattes paa en Række Karter. For Grønlandshavets og det norske Havs

From the figures given as means for every 5th day, I constructed, by interpolation, a Table, which, for every day from the 1st of July to the 30th of September, indicates the quantity that, added to any observation taken on the day corresponding, reduces the latter to the 15th of August.

The observations thus reduced were set down on a series of maps. With regard to the Greenland Sea and

Vedkommende afsattes Observationerne paa et særskilt Kart for hvert af de ovennævnte Expeditionsaar samt for de norske og danske Skibsobservationer, og paa hvert af disse Karter droges de til Temperatursystemet hørende Isothermer. For flere Systemers Vedkommende var dette et let Arbejde, f. Ex. for vor Nordhavsexpedition. For andre Systemer, hvor Observationerne vare mindre regelmæssig fordelte, maatte disse først samles i Grupper, og Middeltallet af disse beregnes og indføres paa den Plads, der indtoges af Gruppens Tyngdepunkt. Dernæst construerede jeg for hver Breddegrad, fra den 80. til den 55., efter de nævnte Isothermer, Curver, der viste Temperaturens Størrelse langs hver Breddegrad i hvert Observations- eller Aars-System. Efter Antallet af disse fik jeg saaledes paa de Partier, hvor Systemerne overskar vedkommende Breddeparallel, Curver eller Stumper af Curver for Havoverfladens Temperatur til forskjellige Aar eller Rækker af Aar. Af de forskjellige Curvers Ordinater toges Middeltal, og gjennem de til dem svarende Punkter droges en Mediumscurve, der, saavidt det benyttede Materiale tillod, fremstiller Temperaturens normale Stand langs vedkommende Breddeparallel i Midten af August. Beregningen af Middeltallene, der kunde uddrages af fra 2 indtil 7 Enkeltværdier, har ogsaa kunnet tjene til at finde den gjennemsnitlige Afvigelse af et enkelt Aars Observation fra det normale Medium og Maximumafvigelsen. Paa de fundne normale Curver afsattes deres Skjæringspunkter med de horizontale Linier for hver hel Grad, og disse Punkter overførtes paa et Kart paa de tilsvarende Længder. Gjennem de saaledes fundne Snitpunkter droges derpaa Havfladens Isothermer.

For Østhavets og Danmarkstrædets Vedkommende bleve Observationerne samtlige afsatte i samme Kart, og inddelte i Grupper, hvis Middeltal indtegnedes i Gruppens Tyngdepunkt, hvorpaa Isothermerne droges efter disse Media. Ved Beregningen af Gruppemiddeltallene er der, for det nordlige Østhavs Vedkommende — Øst-Spidsbergen-Nord-Novaja-Semlja —, taget Hensyn til, at Observationerne falde i gunstige Is-Aar. For hvert saadant er i Middeltallets Beregning indtaget som Compensation en Temperatur af -1^{0}. Herved tror jeg at være kommen det normale Temperaturmedium nærmere.

Resultatet af disse Constructioner og Beregninger foreligger i Kartet Pl. XXVII. Ifølge 54 forskjellige Bestemmelser, der variere mellem $0^{0}.4$ og $1^{0}.5$, er i Gjennemsnit den midlere Afvigelse af en enkel (et enkelt Aars) Temperaturobservation paa et Sted fra den normale $\pm 0^{0}.90$, og man tør saaledes, da det gjennemsnitlige Antal af Observationer for hvert Medium er 5.6, sætte Usikkerheden af Kartets Temperaturangivelse for et enkelt Sted til $\pm 0^{0}.38$. De forskjellige Breddegrader udvise ikke nogen merkelig Forskjel i denne Henseende. Den midlere Maximumsaf-

the Norwegian Sea, the observations were put down on separate maps, one for each year of the above-mentioned Expeditions, as also for the Norwegian and Danish vessels, and on each of these maps were drawn the isotherms resulting from the system of observations. With several of the systems, this was an easy matter, e. g., with that from the North-Atlantic Expedition. With other of the systems, in which the observations occurred less regularly distributed, these had first to be collected into groups, and the mean computed and placed where the group was found to have its centre of gravity. I then constructed for each parallel of latitude, from the 80th to the 55th, by means of the fore-mentioned isotherms, a corresponding number of curves, exhibiting the course of the temperature along each parallel of latitude in every observing or yearly system. According to the number of such, I obtained, therefore, in the tracts where the systems cut the respective parallel of latitude, curves or fragments of curves for the temperature of the sea-surface in different years or series of years. Of the various curve-ordinates was taken the mean, and a mean curve was then drawn through the points corresponding to the said mean numbers. This curve represented, so far as the material made use of would admit, the normal distribution of temperature along the respective parallel of latitude in the middle of August. The computed mean values, based on from 2 to 7 single determinations, have likewise served to find the average deviation of a single year's observation from the normal mean and the maximum deviation. On the normal curves thus found, the points of intersection with the horizontal lines for every whole degree, were marked off and these points transferred to a map along the corresponding degrees of longitude. Through the points of intersection thus found, the isotherms of the sea-surface were then drawn.

As regards the Barents Sea and Denmark Strait, all the observations were put down on one and the same map, and arranged in groups, the means for which being placed in the centre of gravity of the group, after which the isotherms were drawn from these means. When computing the mean number for each group, regard had to be taken, as concerns the northern tract of the Barents Sea, viz., East Spitzbergen-North Novaja Semlja, that the observations are derived from favorable ice-years. For every such observation, a temperature of -1^{0} has been introduced as compensatory in calculating the mean. Thus I make venture to assume I have reached a closer approximation to the normal mean temperature.

The result of these constructions and computations is given in the Map, Pl. XXVII. According to 54 different determinations, varying between $0^{0}.4$ and $1^{0}.5$, the mean deviation of a single (a single year's) observation of temperature from the normal average in any given place is $\pm 0^{0}.90$; and therefore, since the average number of observations for each mean is 5.6, we may put the uncertainty of the Map's indication of temperature for any given place at $\pm 0^{0}.38$. The various parallels of latitude do not exhibit any appreciable difference in that respect. The mean max-

vigelse af en enkelt Observation fra det normale Medium er $\pm$ 1°.7. Den absolute Maximumsafvigelse er 2°.5. Ved Observation af Havoverfladens Temperatur i Sommermaanederne, reduceret til Midten af August, maa man altsaa i vort Nordhav være belavet paa at finde den indtil et Par Grader højere eller lavere end den normale. For at bringe den sandsynlige Fejl af Normalmediet ned til $\pm$ 0°.1 udfordres Observationer fra 81 Aar.

Til Construction af Kartet for Havoverfladens normale Temperatur i Marts foreligger, for Strækningen fra Nordsøen forbi Shetland til Jan Mayen og Grønlandshavet nordenfor denne Ø, 19 Aars Observationer (1867—85) fra norske Sælfangere. Blandt disse have især været virksomme Captejnerne Carsten Bruun, Jacob Melsom, Axel Krefting, L. Grønvold og L. H. Castberg, der have indsendt sine Iagttagelser til det norske meteorologiske Institut. Disse Observationer har jeg, for Marts Maaned, da Variationen er ringe, afsat uden Reduction til Midten af Maaneden, paa et Kart, og tegnet Isothermer efter dannede Gruppemedia.

For at kunne fortsætte disse Isothermer op til Spidsbergen har jeg paa den ene Side benyttet de Iagttagelser, der ere gjorte i Dybet i Magdalene Bay, Nordvest-Spidsbergen, og paa den anden Side de Iagttagelser, som gjordes under "Alberts" Rejse til Spidsbergen i November og December 1872.

I Dybet af Magdalene Bay fandt Charles Martins, Medlem af Expeditionen med "La Recherche", i August 1839 Temperaturer fra —1°.7 til —1°.9 [1]. Sammesteds fandt jeg i August 1878 Temperaturer fra —1°.8 til —2°.1. Disse lave Temperaturer maa hidrøre fra Vinterkulden i Overfladen, og jeg sætter derfor Temperaturen i den koldeste Maaned, Marts, ved Nordvest-Spidsbergen til —2°.

Efter Meddelelse fra Capt. Carsten Bruun, der i 20 Aar har drevet Sælfangst ved Jan Mayen, gaar den midlere Isgrændse (Pakisen) om Vinteren fra et Punkt 3° østenfor Jan Mayen mod NNE til 75° N. Br., 0° Længde, hvor den danner det saakaldte Is-Nes. Idet den her pludselig vender sig mod WNW, danner den en stor Bugt, der væsentlig hidrører fra vedholdende østlige Vinde. Den inderste Vig af denne Bugt ligger mellem 76° og 77° N. Br. og fra 5° til 10° vestlig Længde. Bugtens nordlige Bred dannes af Isgrændsen, der løber mod ENE hen til Spidsbergen. Efter denne Isgrændse har jeg trukket Isothermen for —2° for Marts fra Jan Mayen til Nordvest-Spidsbergen.

Paa Rejsen til Spidsbergen fandt Capt. Otto [2] den 24. November 1872 i Sydvest for Spidsbergens Sydkap,

[1] Voyages en Scandinavie, en Laponie et au Spitzberg de la corvette La Recherche — Géographie physique, II, p. 349.

[2] Alberts Expedition til Spidsbergen i November og December 1872 og dens videnskabelige Resultater. Christiania Videnskabs-Selskabs Forhandlinger for 1873.

imum-deviation of a single observation from the normal mean, is $\pm$ 1°.7. The absolute maximum-deviation is 2°.5. When measuring the temperature of the sea-surface during the summer-months, reduced to the middle of August, we must, therefore, be prepared to find it in the Norwegian Sea some two or three degrees higher or lower than the normal. In order to bring down the probable error to $\pm$ 0°.1, observations are required extending over a period of 81 years.

For constructing a map that shows the normal temperature of the sea-surface in March, we have for the tract from the North Sea past Shetland to Jan Mayen and the Greenland Sea north of the latter island, 19 year's observations (1867—1885), furnished by Norwegian sealers. Amongst the captains distinguished as specially energetic, we can mention *Carsten Bruun, Jacob Melsom, Axel Krefting, L. Grønvold*, and *L. H. Castberg*, who sent in their journals to the Norwegian Meteorological Institute. These observations I have set down for the month of March, without reduction to the middle of that month, the variation being inconsiderable, on a map, and have drawn the isotherms from the means of collected groups.

In order to extend these isotherms as far north as Spitzbergen, I have, on the one hand, made use of the observations taken throughout the depths of Magdalena Bay, north-west coast of Spitzbergen, and, on the other, those made during the cruise of the "Albert" to Spitzbergen, in November and December 1872.

In the depths of Magdalena Bay, M. Charles Martins, member of the Expedition with "La Recherche," found, during the month of August 1839, a temperature ranging from —1°.7 to —1°.9. [1] Throughout the same locality, in August 1878, I registered a temperature varying from —1°.8 to —2°.1. These low temperatures must obviously originate in the winter-cold of the surface; and hence I put the temperature on the north-west coast of Spitzbergen during March, the coldest month of the year, at —2°.

According to a statement communicated by Capt. Carsten Bruun, who, during the space of 20 years, has been engaged in the seal-fishery off Jan-Mayen, the mean ice-limit (of the pack) in winter extends from a point 3° east of Jan Mayen towards the NNE, as far as lat. 75° N, long. 0°, where it forms the so-called ice-cape. Here, diverging suddenly towards the WNW, it constitutes a large bay, chiefly the result of continuous easterly winds. The inmost creek of this bay lies between lat. 76° and lat. 77° N and long. 5° to long. 10° W. The northern shore of the bay is formed by the ice-limit, which, passing ENE, reaches up to Spitzbergen. Along the tracts of the ice-limit, I have drawn the isotherm for —2°, in March, from Jan-Mayen to the north-west coast of Spitzbergen.

On his voyage to Spitzbergen, Capt. Otto [2] found on the 24th of November 1872, to the south-west of South

[1] Voyages en Scandinavie, en Laponie et au Spitzberg de la corvette La Recherche — Géographie physique, II, p. 349.

[2] Petermanns Geographische Mittheilungen f. 1873. Ocean Highways, June 1873, p. 104.

76° N. Br., 14° E. Lgd., en Temperatur i Havfladen af over 4°. Her var aabenbart en Tungespids for 4°-Isothermen. Samtidig var Temperaturen ved Fruholm 4°, hvilket er omtrent den normale Temperatur for Aarstiden. Ved Fruholm er den normale Temperatur for Marts 2°.4, eller 2°.0 lavere end Normaltemperaturen for den 24. November. En ligefrem Reduction giver Temperaturen for Marts paa "Alberts" ovennævnte Plads lig lidt over 2°. Imidlertid fandt Capt. Otto den 7. December under 71° N. Br. 16°.5 E. Lgd. en Temperatur af 6°.5, hvilket er 0°.5 højere end Aarets Medium paa dette Sted. Aarsmediet for Fruholm er 5°.0, og Mediet for den 7. December 4°.0, altsaa skulde den observerede Temperatur paa "Alberts" sidstnævnte Sted være 1°.5 for højt eller den normale Temperatur her for den 7. December 5°.0 og for Marts (4°—2°.4) 1°.6 lavere eller 3°.4, et Tal, som stemmer godt med mit endelige Kart. Jeg sætter derfor Temperaturen for Marts under Sydkap lavere end 2°, og lægger Tungespidsen for Isothermen for 2° paa lavere Bredde, paa 75°.5. Forøvrigt har jeg ladet Isothermen for 2° danne en Tunge, hvis Axe falder sammen med den af "Alberts" Observationer fremgaaende Tunge for 4°.

Til Constructionen af Marts-Isothermerne for Østhavet og Danmarkstrædet har jeg, da Observationer ganske mangle, maattet benytte en anden Fremgangsmaade. Idet jeg har støttet mig til Observationerne fra Kyststationerne og Betragtningen af Isgrændserne tidlig om Vaaren, samt efter Analogi med Temperaturens Fordeling i Havets Overflade om Sommeren og i Luften om Vinteren, har jeg først gjort et Udkast til Havisothermernes Løb i Marts. Efter dette Udkast og August-Isothermerne beregnedes den aarlige Variation, og bleve Linier for ligestor aarlig Variation forsøgt opconstruerede i Kartet. Det noget uregelmæssige og mindre sandsynlige Løb af disse Linier corrigeredes saaledes, at Variationslinierne fik et regelmæssigt Løb (se Pl. XXIX). Ved Hjelp af disse nye Linier for ligestor aarlig Variation kunde jeg derpaa gaa directe over fra August-Isothermerne til de paa Kartet Pl. XXVIII fremstillede Isothermer for Havoverfladen i Marts.

Til Isothermerne for Nordsøen har jeg benyttet Observationer fra norske Handelsfartøjer.

Aarets Middeltemperatur har jeg beregnet paa følgende Maade. Kaldes Middeltemperaturen for August M, for Marts m og for Aaret A, saa kan man sætte

$$A = \tfrac{1}{2}\,(M+m) - f\,(M-m)$$

hvor f er en constant Factor og $M-m$ den aarlige Variation fra Marts til August, fra den koldeste til den varmeste Maaned. Factoren f udledes af Observationerne fra Kyststationerne. Hver af disse giver en Ligning af ovenstaaende Form, og man faar, naar Σ betyder Summationstegn,

$$\Sigma\, A = \Sigma\, \tfrac{1}{2}\,(M+m) - f\,\Sigma\,(M-m)$$

Cape, Spitzbergen, lat. 76° N, long. 14° E, a temperature at the sea-surface reaching upwards of 4°. This was clearly the extremity of the tongue formed by the 4° isotherm. The temperature at the same time at Fruholm was 4°, which is about the normal temperature for that time of year. At Fruholm, the normal temperature for March is 2°.4, or 2°.0 lower than the normal temperature for the 24th of November. A direct reduction of the temperature at the forestated position of the "Albert," gives for March a trifle over 2°. Meanwhile, Capt. Otto found, on the 7th of December, in lat. 71° N, long. 16°.5 E, a temperature of 6°.5, or 0°.5 higher than the annual mean determined for that locality. The annual mean for Fruholm reaches 5°.0, and the mean for the 7th of December 4°.0: hence the temperature observed by the "Albert" at the last-mentioned place should be 1°.5 too high, or the normal temperature here for the 7th of December be 5°.0 and for March (4°—2°.4) 1°.6 lower, or 3°.4, a result exhibiting very satisfactory agreement with my finally constructed map. Hence, I put the temperature for March, in close proximity to South Cape, lower than 2°, and draw the point of the isothermal tongue for 2° on a lower parallel of latitude, viz., 75°.5. For the rest, I have let the isotherm for 2° form a tongue the axis of which is congruent with the tongue for 4° resulting from the observations of the "Albert."

In order to construct the March-isotherms for the Barents Sea and Denmark Strait, I had necessarily, observations being wholly wanting, to adopt another mode of operation. Taking regard to the observations from the Coast-Stations, as also to the ice-limit early in the spring, and in accordance with analogy as shown by the distribution of temperature at the surface of the sea in summer and in the atmosphere during winter, I first drew a rough sketch of the course taken by the sea-isotherms in March. From this sketch and the August-isotherms, I computed the annual range, and drew lines for an equal annual range on the map. The somewhat irregular, and comparatively improbable, run of these lines was corrected by giving the lines of range a regular course (See Pl. XXIX). With these new lines for an equal yearly range, I could then pass directly over from the August-isotherms to the isotherms drawn on Pl. XXVIII for the sea-surface in March.

When constructing the isotherms for the North Sea, I made use of the observations taken by Norwegian merchant vessels.

Now, calling the mean temperature for August M, that for March m, and that for the whole year A, we can put

$$A = \tfrac{1}{2}\,(M+m) - f\,(M-m),$$

in which formula f is a constant factor and $M-m$ the annual range from March to August, from the coldest to the warmest month. The factor f is determined from the observations taken at the Coast-Stations. Each of these gives an equation of the above form; and we get, with Σ as the sign of summation,

$$\Sigma\, A = \Sigma\, \tfrac{1}{2}\,(M+m) - f\,\Sigma\,(M-m),$$

eller den sandsynligste Værdi af f

$$f = \frac{\Sigma \frac{1}{2}(M+m) - \Sigma A}{\Sigma (M-m).}$$

Til Bestemmelsen af Factoren f har jeg udvalgt følgende Stationer, der nærmest kunne repræsentere det aabne Nordhav:

or the most probable value of f,

$$f = \frac{\Sigma \frac{1}{2}(M+m) - \Sigma A}{\Sigma (M-m).}$$

For determining the factor f, I made choice of the following Stations, which may be taken as most nearly representing the conditions of the Norwegian Sea at large.

	M	m	A_o	M-m	$\frac{1}{2}(M+m)$	$f(M$-$m)$	A_c	A_o-A_c
Lindesnes	$15^0.7$	$3^0.1$	$8^0.7$	$12^0.6$	$9^0.4$	$0^0.8$	$8^0.6$	$+0^0.1$
Udsire	15.4	4.2	9.0	11.2	9.8	0.7	9.1	-0.1
Hellisø	13.9	4.5	8.7	9.4	9.2	0.6	8.6	+0.1
Ona	13.0	4.0	8.0	9.0	8.5	0.6	7.9	+0.1
Fruholm	8.5	2.4	5.0	6.1	5.5	0.4	5.1	-0.1
East Yell	12.2	7.2	9.4	5.0	9.7	0.3	9.4	0.0
Sandwick	12.9	6.7	9.3	6.2	9.8	0.4	9.4	-0.1
Thorshavn	10.8	5.4	7.9	5.4	8.1	0.4	7.7	+0.2
Papey	6.8	0.7	3.3	6.1	3.8	0.4	3.4	-0.1
Grimsey	8.1	1.4	4.6	6.7	4.8	0.4	4.4	+0.2
Jan Mayen	2.8	-1.6	0.0	4.4	0.6	0.3	0.3	-0.3
Sum			73.9	82.1	79.2			0.0

$$f = \frac{79.2 - 73.9}{82.1} = \frac{5.3}{82.1} = 0.065$$

Den midlere Afvigelse mellem de observerede og beregnede Aarsmedier bliver $\pm\ 0^0.13$.

Man har saaledes til Beregningen af Aarsmediet

The mean deviation between the observed and the computed annual means, will be $\pm\ 0^0.13$.

Hence, for computing the annual mean, we have

$$A = \frac{1}{2}(M+m) - 0.065\,(M-m) = m + (0.5 - 0.065)\,(M-m) = m + 0.435\,(M-m).$$

Beregningen har jeg udført paa grafisk Vej, idet efter Kartet Pl. XXVIII Curverne for Marts, for Parallelgrader i Grønlandshavet og det norske Hav og for hver 5. Længdegrad i Østhavet, sattes under de for August tidligere optrukne. Med en Proportionspasser, stillet efter Forholdet 1 : 0.435, toges paa den større Side Værdierne af M—m, Passeren vendtes om og fra Martsordinaterne m afsattes med den anden Side af Passeren opad Værdien 0.435 (M—m). Herved erholdt jeg en Række Ordinater for A_c, der forbandtes med en Curve. Fra denne afsattes dens Skjæringspunkter med Horizontallinierne for de hele Grader paa et Kart, og Isothermerne for Aaret indtegnedes gjennem disse Punkter. Ved Hjelp af Kyststationerne og for Nordsøens Vedkommende Resultatet af Skibsobservationer fra alle Aarets Maaneder completteredes Kartet. Saaledes er Kartet, Pl. XVI, over Havoverfladens aarlige Middeltemperatur kommet istand.

The calculation I made diagrammatically, placing the curves for March drawn from the isotherms, Pl. XXVIII, under the curves previously drawn for August, for the parallels of latitude in the Greenland Sea and the Norwegian Sea, and for every 5th degree of longitude in the Barents Sea. With a pair of proportional compasses, set at 1 : 0.435, I first measured, with the long legs, the values of M—m; the compasses were then inverted, and from the March ordinates m I marked off upwards, with the other or shorter legs of the compasses, the value 0.435 (M—m). In this way I obtained a series of ordinates for A_c, which were combined into a curve. From the latter, its points of intersection with the horizontal lines for the whole degrees were marked off on a map and the isotherms for the year drawn through the said points. By means of the Coast-Stations, and, as regards the North Sea, the result of merchant ships' observations for all months in the year, the map was completed. Thus it proved practicable to construct the map, Pl. XVI, showing the annual mean temperature of the sea-surface.

Om Nøjagtigheden af dette Kart for de Strækningers Vedkommende, hvor der foreligger Observationer baade for August og for Marts (det norske Hav og en Del af Grønlandshavet)kunne følgende Beregninger anstilles. Sættes Usikkerheden af saavel August- som Marts-Kartets Temperaturangivelser for et enkelt Punkt i Havet til $\pm\ 0^0.38$, saa bliver den deraf flydende Usikkerhed i Aars-Kartet $\pm\ 0^0.27$.

Concerning the accuracy of this map in regard to the tracts where observations had been taken both for August and for March (the Norwegian Sea and part of the Greenland Sea), the following calculations can be made. Putting the uncertainty of the statements, alike in the maps for August and March, with respect to the temperature for a single point of the sea at $\pm\ 0^0.38$, the uncertainty thence resulting in the map for

Hertil kommer den ved Beregningen med Factoren f indførte Usikkerhed, der beløber sig til $\pm$ 0°.13, og Kartets midlere Usikkerhed bliver saaledes $\pm$ 0°.28. Om Nøjagtigheden paa de Strækninger, hvor Marts-Observationer mangle, tør jeg ikke udtale nogen begrundet Dom. Usikkerheden tør nok paa sine Steder overstige en Grad.

Fordelingen af Havoverfladens aarlige Middeltemperatur er tidligere beskrevet (Side 71 fg.). Sammenligner man Karterne for August og for Marts med Aarskartet, vise de samme Tungeformer hos Isothermerne sig paa samme Steder i alle tre Karter, undtagen i August udenfor Norges Kyst. Her er Tungernes Axe saaatsige kastet ind paa Land, Isothermerne stige skraat opad mod Kysten uden at bøje om; kun Tungernes vestre Halvdel ligger over Havet. Aarets Temperatur-Fordeling ligner mest Vinterens, der bliver den Aarstid, som behersker Havoverfladens Klima.

Kartet Pl. XXIX viser Størrelsen og Fordelingen af Havtemperaturens aarlige Variation fra August til Marts i Overfladen. Dette Kart er construeret directe efter Temperaturkarterne for de nævnte Maaneder. Den aarlige Variation er størst i Skagerak og den østlige Del af Nordsøen, dernæst ved Norges Vestkyst. Her er baade Sommervarmen og Vinterkulden i Atmosfæren virkende til at bringe Variationen op til en større Højde. Herfra aftager dens Størrelse raskt og jevnt ud mod det norske Hav, hvor den kun frembyder mindre Afvexlinger. Et Maximum paa over 6° viser sig paa Strækningen mellem Jan Mayen og Beeren-Eiland, der maaske er det Parti, hvor Isgrændsens Beliggenhed varierer mest i Aarest Løb, og hvor, som Tversnit XVII, Pl. XII, viser, der om Sommeren er en sterk Contrast mellem Temperaturen i Overfladen og i 40 Favnes Dyb. En lidt større Indflydelse fra Dybet vilde let udslette dette Maximum af aarlig Variation. Et andet Maximum findes i Nordost for Island. Dette lader sig ikke eliminere efter de forhaandenværende Observationer. Maxima komme frem ogsaa udenfor Nordvest-Spidsbergen, vestenfor Island og mellem Færoerne og Shetland. Mindre Minima af aarlig Variation vise sig udenfor Islands Østkyst og i Vest for Shetland. Hvor Isen dækker Havet hele Aaret, i den vestlige Del af Grønlandshavet og mellem Spidsbergen og Novaja Semlja, gaar Havtemperaturens aarlige Variation ned til 2°, et Tal, der betegner Afstanden mellem Havvandets Frysepunkt, — 2°, og Isens Smeltepunkt ved 0°.

9. Temperaturens Fordeling i de øvre Lag i Havet i den varmeste og den koldeste Maaned.

Temperaturens midlere aarlige Fordeling i de øvre Lag mellem Overfladen og 100 Favnes Dyb er fremstillet i Tversnittene Pl. IX til XV. I Regelen ligger den højeste

the whole year will be $\pm$ 0°.27. To this comes the uncertainty introduced by the computation with the factor f, amounting to $\pm$ 0°.13, and thus the mean error of the map becomes $\pm$ 0°.28. Concerning the accuracy throughout the tracts for which March-observations are wanting, I cannot venture to express any definite opinion. The error may possibly in some places reach upwards of a degree.

The distribution of the mean annual temperature of the sea-surface has been previously described (p. 71). Now, if we compare the maps for August and for March with the map for the year, the tongues of the isotherms assuming a similar shape will be found to occupy the same places in all three maps, with the exception of August off the coast of Norway. Here, the axis of the tongues is cast in, as it were, upon the land; the isotherms rise up obliquely towards the coast without any bend, and the left half only of the tongues extends over the sea. The annual distribution of temperature presents greatest resemblance to that of winter — the season of year found to dominate the climate of the sea-surface.

The map, Pl. XXIX, shows the amount and the distribution of the annual range of the sea-temperature from August to March at the surface. This map has been constructed direct from the temperature-maps for the said months. The annual range is greatest in the Skagerak and the eastern part of the North Sea, next along the West Coast of Norway. Here, both the summer-heat and the winter-cold in the atmosphere contribute to increase the range. From this locality, the range diminishes rapidly and gradually towards the Norwegian Sea, where it exhibits but minor variations. A maximum, reaching upwards of 6°, occurs between Jan Mayen and Beeren Eiland — maybe, the tract of ocean where the ice-limit varies most in position throughout the year, and where, too, as shown by transverse section XVII, Pl. XII, a striking contrast prevails in summer between the temperature at the surface and that at a depth of 40 fathoms. A somewhat greater influence from the deep would easily do away with this maximum of annual range. Another maximum is found north-east of Iceland. This will not admit of being eliminated with the observations at my command. Maxima occur likewise off the north-west coast of Spitzbergen, west of Iceland, and between the Færoes and Shetland. Minor minima of annual range occur off the east coast of Iceland and west of Shetland. In localities where ice covers the ocean the whole year round, viz., in the western part of the Greenland Sea and between Spitzbergen and Novaja Semlja, the annual range of sea-temperature reaches only 2°, a figure indicating the difference between the freezing-point of sea-water, —2°, and the melting-point of ice, 0°.

9. Distribution of Temperature throughont the Upper Strata of the Ocean during the Warmest and the Coldest Month of the Year.

The mean annual distribution of temperature throughout the upper strata between the surface and a depth of 100 fathoms, is represented in tranverse sections

Temperatur i Overfladen, men paa nogle Steder, som paa Island-Færø-Ryggen og vestenfor Beeren Eiland og Spidsbergen, ligger Temperaturens Maximum under Overfladen.

Pls. IX to XV. As a rule, the highest temperature occurs at the surface; but in some localities, as, for example, on the Iceland-Færoe Ridge and west of Beeren Eiland and Spitzbergen, the maximum of temperature is found beneath the surface.

For at studere Temperaturens Fordeling i disse Lag i de extreme Maaneder har jeg construeret Tversnittene Pl. XXX og XXVI. Disse ere de samme som de paa Pl. IX til XIII med Undtagelse af de mindre Snit over de norske Kystbanker. De ere betegnede med de tilsvarende Nummere. De gaa fra Overfladen til 200 Favnes Dyb. Stykket mellem 100 Favne og 200 Favne er copieret efter Pl. IX til XIII. Det øverste af hvert Par Snit Pl. XXX og XXVI viser Temperaturfordelingen i August, det nederste i Marts. Overfladetemperaturerne ere afsatte efter Karterne Pl. XXVII og Pl. XXVIII. Desuden er for August benyttet til Vejledning for Trækningen af Isothermerne Temperaturrækkerne Pl. III til VIII, der ere tagne om Sommeren. For Marts Maaneds Vedkommende er der taget Hensyn til, at Temperaturen ifolge vore Sælfangeres Iagttagelser voxer raskere med Dybden i de øvre end i de dybere Lag.

With a view to study the distribution of temperature throughout these strata in the two extreme months of the year, I constructed the tranverse sections Pls. XXX and XXVI. These are the same as those in Pls. IX to XIII, except the minor sections crossing the Norway coastal banks. They are indicated by the corresponding numbers, and extend from the surface to a depth of 200 fathoms. The part between 100 and 200 fathoms is copied from Pls. IX to XIII. The upper of each pair of sections, Pls. XXX and XXVI, exhibits the distribution of temperature in August, the lower that in March. The surface-temperatures are marked off from the maps, Pls. XXVII and XXVIII. Moreover, for August, to assist in drawing the isotherms, I have made use of the serial temperatures, Pls. III to VIII, taken during the summer months. Concerning March, regard has been had to the observation of our sealers, that temperature increases more rapidly with depth in the upper than in the lower strata.

Af disse Tversnit fremgaar, at Temperaturen i August overalt er hojest i Overfladen og i Havet synker stadigt med Dybden. Under Kysterne findes flere Steder de ovenfor beskrevne Temperaturminima i Dybder mellem Overfladen og 100 Favne (Tversnittene XV, XXIII), og ved Spidsbergens Sydkap ligger Maximum under Overfladen. Her driver jevnlig om Sommeren Is sydover fra Storfjorden. I det norske Hav, navnlig i dets sydlige og østlige Del, ligge Sommerens Isothermer meget tæt i de øverste Lag.

From these transverse sections, it appears that the temperature in August is everywhere highest at the surface, sinking, out at sea, steadily with the depth. In close proximity to the coasts, the above-described temperature-minima occur at several places between the surface and a depth of 100 fathoms (Tranverse Sections XV, XXIII); and at South Cape, Spitzbergen, the maximum lies beneath the surface. Here, ice is found continually drifting during summer from the Storfjord southwards. In the Norwegian Sea, more particularly throughout its southern and eastern parts, the summer-isotherms lie exceedingly close throughout the uppermost strata.

I Marts derimod se vi, at Regelen er den, at Overfladen er koldere end Vandet i 100 Favnes Dyb. Temperaturen voxer i de mellemliggende Lag med Dybden. De eneste Undtagelser herfra findes under den 63. Breddegrad (Tversnit VIII) udenfor Norges Kyst, hvor Temperaturen er 7° gjennem hele Laget, og i Østhavet mellem Vardø og Novaja Semlja (Tversnit XXVII), hvor Havet er forholdsvis grundt, og det iskolde Vand ligger forholdsvis nær Overfladen.

During the month of March, on the other hand, we see that, as a rule, the water at the surface is colder than at a depth of 100 fathoms. The temperature increases throughout the intermediate strata with the depth. The only exceptions are found on the 63rd parallel of latitude (Tranverse Section VIII), off the coast of Norway, where the temperature is 7° throughout the whole stratum, and in the Barents Sea, between Vardø and Novaja Semlja (Transverse Section XXVII), where the water is comparatively shallow, and the ice-cold stratum lies comparatively near the surface.

Med faa Ord kan Forholdene beskrives saaledes. Om Sommeren ligne Isothermobatherne en Bue, der vender sin hule Side opad. Om Vinteren lukker denne Bue sig fra Siderne — Kysterne, Grønlandsisen — af sammen oventil og danner en langstrakt Oval, der omslutter den højeste Varmegrad i omkring 100 Favnes Dyb. Det er Vinter-Kulden fra Atmosfæren, der lægger sig ud over Havet, i sterkest Grad ved Kysterne og i de koldere arktiske Egne, i svagest Grad over Havets og Luftens Varme-

To be brief, the general distribution of temperature may be described as follows. During summer, the isothermobaths take the form of an arcuate curve, with the concave side upwards. During winter, this curve is found to bend over at the sides — the coasts, the Greenland ice — forming an elongated oval, which encloses the highest temperature at a depth of about 100 fathoms. It is the winter-cold from the atmosphere, that spreads out over the sea, acting most forcibly off the coasts and in the colder Arctic regions,

axe. Det er ikke den varme Strøm fra Syden, der dukker under, men den samme, der afkjøles paa sin Overflade.

Observationerne fra den norske Kyst, navnlig fra Lødingen og Altenfjorden, samt fra Grønlandshavet have vist os, hvorledes Temperaturens aarlige Vandring her foregaar under Lufttemperaturens Indflydelse. Vi kunne ogsaa forstaa, hvorledes Vinterkulden lægger sig ud over Havets Overflade og gjør denne koldere end Dybet. Men hvorledes Overgangen ude i det aabne Hav sker fra Vinter til Sommer, derom kunne vi være i Tvivl. Vi kunne tænke os, at Luften om Vaaren opvarmer de øvre Lag, hvorved der vilde fremkomme et Minimum af Varme under Overfladen, der, efterhaanden som Opvarmningen skred frem, vilde synke dybere ned, indtil Temperaturen, som om Sommeren, aftog stadig fra Overfladen til 100 Favnes Dyb. Dette vilde svare til, hvad der finder Sted under Kysten. Eller vi kunne tænke os, at det fra Syden tilstrømmende Vand tiltog i Varme i Vaarens Løb, og saaledes, førende den høieste Temperatur i Overfladen, afløste Vandlagene fra Vinteren. Paa et og samme Sted vilde om Vinteren Isothermernes øverste Del være bøiet tilbage mod Syd (som mellem 70° og 73° N. Br. i Tversnit XXVIII); om Vaaren vilde efterhaanden Isothermerne rette sig op, idet de antog sydligere Egnes Character (62° til 67° N. Br. i Tversnit XXVIII), og ende med om Sommeren at pege med sin øverste Del mod Nord. Eller Temperaturcurven for Stedet, der om Vinteren skraanede med sin øvre Ende mod Kuldegraderne, vilde om Vaaren efterhaanden blive mere og mere vertical, overskride denne Stilling og helde om Sommeren med sin øvre Ende mod de høiere Varmegrader, uden at frembyde Inflexionspunkter. Den sidste Betragtningsmaade antager jeg kommer Virkeligheden nærmest, da Luftens Temperatur om Vaaren og idethele over Havet er lavere end Havoverfladens, og da Strømninger, udgaaende fra varmere Egne, kunne paavises at være tilstede i de Dele af Nordhavet, hvorom her er Spørgsmaal.

Over det norske Hav ligger i alle Maaneder gjennemsnitlig et Minimum af Lufttryk. Sterkest udpræget er dette i Vintermaanederne[1]. I disse ligger et Maximum af Lufttryk over den centrale Del af den skandinaviske Halvø. Ifølge den bariske Vind-Lov blive de herskende Vinde Landvinde. Fra alle Kanter, fra Øst-Island, fra Norge, fra Spidsbergen, fra Grønlandsisen strømme disse Vinde ud over Nordhavet. Disse Egne have om Vinteren en Luft-Temperatur, der er meget lavere end den over Havet[2]; de herskende Vinde bringe den kolde Landluft ud over de Strækninger af Havet, der ligge ved Kysterne (Isgrændsen). De afkjøle Havets Overflade, sterkest ved Kysten, mindre i større Afstand fra denne, hvor de opvarmes af det varmere Hav. Dette er Landkulden, som lægger sig over Havet,

[1] Oestr. Zeitschrift für Meteorologie 1883.

[2] Sammesteds. Kart over Luftens Temperatur i Januar.

least sensibly over the thermal axis for the air and the sea. It is not the warm current from the south dipping down, but this current cooled off at its surface.

The observations from the coast of Norway, in particular Lødingen and the Altenfjord, together with those from the Greenland Sea, have shown us the annual variation of the temperature here as affected by the temperature of the air. We can, too, comprehend how the cold of winter extends over the sea-surface, making it colder than the water of the deep. But in what manner the transition from winter to summer proceeds out in the open sea, we have reason to question. The air in spring might be assumed to warm the upper strata, and thus give rise to a minimum of heat beneath the surface, which, by degrees, as the warming progressed, would sink deeper down, till the temperature, as in summer, was found to steadily diminish from the surface to a depth of 100 fathoms. This mode of propagation would agree with that observed at the coasts. Or, we might imagine the flux of water from the south to increase in heat during the course of spring, and thus, with the highest temperature at the surface, to supplant the winter-strata. In one and the same place, the uppermost part of the isotherms would curve back towards the south during winter (as between lat. 70° and 73° N, in section XXVIII); in spring the isotherms would gradually rise up, assuming the character peculiar to more southern regions (lat. 62° to 67° N, in section XXVIII), and terminate with their uppermost extremity pointing in summer towards the north. Or the temperature-curve for the place in question, which during winter sloped with its upper end towards the lower temperatures, would in spring gradually become more and more vertical, then pass on and incline during summer with its upper extremity pointing towards the higher degrees without exhibiting any points of inflexion. The last view of the subject comes, I opine, the true conditions nearest, since the temperature of the air in spring, and generally above the sea, is lower than that of the sea-surface, and as currents flowing from warmer regions can be shown to exist in those parts of the North Ocean we have to deal with here.

Over the Norwegian Sea extends during all months of the year, on an average, a minimum of atmospheric pressure. Most prominent, this is found to be in winter.[1] During that season a maximum of atmospheric pressure lies over the central part of the Scandinavian peninsula. According to Buijs Ballot's Law, the prevailing winds are land-winds. From all points of the compass — East-Iceland, Norway, Spitzbergen, the ice of the Greenland Sea — these winds blow out over the North Ocean. The said regions have in winter a much lower atmospheric temperature than that observed over the sea;[2] the prevailing winds bring with them the cold land-air and spread it over the tracts of ocean approximating the coast (ice limit). They cool down the surface of the sea, inshore most, less at a greater distance from land, where

[1] Oestr. Zeitschrift für Meteorologie, 1883.

[2] Ibid. Map of Atmospheric Temperature for January.

og hvis afkjølende Virkning efterhaanden forplanter sig ned i Dybet. Saaledes bliver om Vinteren, navnlig ved dens Slutning, Kystvandets og Havets Temperatur stigende med Dybden indtil 100 Favnes Dyb, sterkest i Fjordene og inde ved Kysten selv. Den højere Varme i Dybet reagerer stadig mod denne Afkjøling ovenfra og modsætter sig, at Vandet fryser paa Overfladen. Vi kunne saaledes, med de høje Dybtemperaturer i vore Fjorde og paa vore Banker i Minde, forstaa, hvorfor de norske Kyster og Fjorde holde sig isfri. Fryse de til, sker det kun i de inderste Fjordarme, hvor Dybden er mindre og Overfladen er lidet saltholdig paa Grund af der udmundende Elve. Naar Solen om Vaaren faar mere Magt, opvarmes Kyst- og Fjordvandets Overflade, og denne Opvarmning forplantes nedad. I de øverste Lag aftager Temperaturen med Dybden, medens den i de dybere endnu er uberørt af Vaarens Virkning og voxer med Dybden. Mellem begge Lag er der et Minimum af Temperatur. Dette synker, efterhaanden som de øvre Lag opvarmes videre, dybere ned og naar paa sine Steder om Sommeren helt ned til 100 Favnes Dyb. Temperaturen aftager da stadigt med Dybden. Paa andre Steder formaar Sommervarmen fra Overfladen ikke at drive det saa dybt; det bliver staaende i en mindre Dybde til Høsten. I denne Aarstid begynder Afkjølingen fra Overfladen paanyt og forplanter sig nedover. Der danner sig et Maximum af Temperatur under Overfladen, og dette synker efterhaanden, til det om Vinteren naar det uforanderlige Lag i 100 Favnes Dyb.

they derive in turn an accession of heat from the warmer sea. This is the *land-cold,* that makes its way over the sea, and the cooling effect of which becomes gradually propagated to the deep. Thus it arrives, that in winter, more especially during the latter part of that season, the temperature of the coastal water and that of the sea is found continually increasing with the depth down to 100 fathoms, most rapidly in the fjords and close to the shore itself. The higher temperature in the deep reacts without intermission against this cooling-process from above and prevents the water at the surface from freezing. Hence, bearing in mind the high temperatures in the depths of our fjords and on our banks, we can easily understand how it is the Norwegian coasts and fjords should keep free of ice. And if they freeze, it is only the innermost arms of the fjords, where the depth is less and the surface has a greater proportion of fresh water by reason of the rivers that have their outlet there. When the sun in spring acquires greater power, the surface of the coast-water and that of the fjords gets heated, and this heating process is propagated downwards. In the uppermost strata, temperature diminishes with depth, whereas in the deeper, it is still unaffected by the influence of spring, and increases with the depth. Between both strata lies a minimum of temperature. This sinks by degrees, the more the upper layers become heated, and reaches in summer, in some places, as far down as 100 fathoms. The temperature then diminishes steadily with the depth. In other places, the summer-heat from above is insufficient to carry it to such a depth. The minimum persists in minor depths till autumn. At this season the cooling-process from the surface begins again, and passes downwards. A maximum of temperature forms beneath the surface; and this maximum sinks by degrees till, in winter, it reaches the unvarying layer at a depth of 100 fathoms.

III.

Havets Strømninger.

1. Lufttrykket.

At Strømningerne i Havets Overflade for en meget væsentlig Del fremkaldes ved Vinden, tør man efter de senere Tiders Undersøgelser anse for tilstrækkelig godtgjort. Ligeledes er det bevist [1], at Vindens Virkning paa Havets Overflade forplanter sig til Dybet, og at det er Resultanten af de paa Overfladen virkende Vinde, der er bestemmende for Havets gjennemsnitlige stadige Bevægelse.

For at studere denne Bevægelse i dens Forhold til de virkende Kræfter er det saaledes nodvendigt at kjende den gjennemsnitlige Retning og Hastighed af Vinden, dens Resultant for Aaret, paa den Strækning af Havet, hvis almindelige, gjennemsnitlige Bevægelse man vil undersøge.

Paa de fleste Steder vexle de herskende Vinde i Aarets Løb baade i Retning og Styrke. Virkningen af en saadan Vexling forplanter sig dog ikke langt ned under Overfladen, og den aldeles overvejende Del af Havets Vandmasse faar sin Bevægelse reguleret efter de periodisk vexlende Kræfters Resultant for lange Tidsrum.

Idet vi gaa ud fra, at Havvandets regelmæssige, stadige Bevægelse har opnaaet at blive constant med Hensyn til Tiden, som en Virkning af Aarsagernes seculære Arbejde, gjælder det at finde et Udtryk for Vindens midlere Retning og Hastighed for det tilsvarende Tidsrum. I Betragtning af den korte Tid, der er hengaaet, siden man først begyndte at udføre og samle meteorologiske Iagttagelser, maa den Fremstilling, jeg kan give af Vindens Retning og Hastighed for det normale Aar, blive foreløbig og, for vigtige Egnes Vedkommende, hvorfra Iagttagelser ere yderst sjeldne eller endog ganske mangle, endnu beheftet med stor Usikkerhed. Imidlertid vil den, støttet som den er af den Kundskab, Meteorologien har erhvervet om den Indflydelse, Fordelingen af Land og Hav har paa de herskende Vinde, kunne afgive et godt Udgangspunkt for videre Studium, og

[1] Zöppritz. Wiedemanns Annalen der Physik und Chemie, N. F. III. S. 582.

III.

Ocean Circulation.

1. Atmospheric Pressure.

That the currents of the surface of the sea are occasioned very materially by wind, we may regard as a fact to which researches of recent date have given full confirmation. It has likewise been shown, [1] that the effect of the wind on the surface of the sea becomes propagated to the deep; and moreover, that it is the resultant of the winds acting on the surface which determines the average steady motion of the sea.

Hence, for studying this motion in its relation to the operative forces, it is manifestly imperative to know the general direction and velocity of the wind, i. e. its annual resultant throughout the tract of ocean where the general average motion is sought to be determined.

In most localities, the prevailing winds are found to vary in the course of the year, alike as to direction and force. The effect of such variation, however, does not become propagated far beneath the surface; and by far the greater part of the water of the sea has its motion regulated by the resultant of the periodically varying forces for long spaces of time.

Now, starting from the fact of the regular and steady motion of the sea having become constant in regard to time, as an effect of the secular agency of its causes, we must seek an expression for the wind's mean direction and velocity for the corresponding period. Considering the short period that has elapsed since any attempt was first made to carry out and collect meteorological observations, the representation I can give of the wind's direction and velocity for the normal year must needs be preliminary, and in regard to important tracts, where observations are exceedingly scarce, nay wanting altogether, as yet be clogged with great uncertainty. Meanwhile, it cannot fail, supported as it is by the knowledge meteorology has acquired of the influence which the distribution of land and water exerts on the prevailing winds, to

[1] Zöppritz. Wiedemanns Annalen der Physik und Chemie, N. F. III. p. 582.

tør, som en første Tilnærmelse, i det væsentlige stemme med de virkelige Forhold i Naturen.

Fra vort Nordhav foreligge adskillige Iagttagelser af Vinden. Men dels hobe de sig op paa enkelte Strækninger, der befares af Handelsskibe, dels samle de sig paa enkelte Maaneder, i hvilke Skibsfart foregaar, medens store Strækninger og mange Maaneder kun ere repræsenterede ved enkelte videnskabelige eller Fangst-Expeditioner, og visse Dele aldrig ere besøgte hverken af Søfarende eller af Videnskabsmænd.

Af et saadant Materiale vilde man ikke komme til nogen tilfredsstillende Fremstilling af Aarets normale Vindforhold.

Heldigvis tilbyder sig en anden Fremgangsmaade, der ogsaa har den Fordel, at den med en ganske anden Sikkerhed, end de directe Vind-Observationer, fører til Maalet. Af de sidste Decenniers meteorologiske Undersøgelser fremgaar som det bedst begrundede Resultat den Forbindelse, som finder Sted mellem Lufttrykkets Fordeling og Vindens Retning og Hastighed. Og denne Lov, den bariske Vindlov, gjælder, for de Jorden nærmest værende Luftlag, i sin største Strenghed netop Fænomenerne ved Havets Overflade.

Ere vi saaledes istand til at fremstille Lufttrykkets Fordeling over Havet for det normale Aar, kunne vi deraf med stor Sikkerhed udlede de herskende Vindes normale Retning og Hastighed for det samme Tidsrum.

Vi begynde derfor vore Studier over Havets Strømninger med Undersøgelsen af Lufttrykkets Fordeling i det normale Aar.

Til Bestemmelsen af denne har jeg anvendt følgende Observationer.

Fra de norske meteorologiske Kyststationer Christiania, Sandøsund, Mandal, Skudesnes, Bergen, Aalesund, Christiansund og Vardø haves fuldstændige Observationer for Kl. 8 a. m., Kl. 2 p. m. og Kl. 8 p. m. fra Januar 1867 af, udførte med Instrumenter, der stadig have været controllerede. Disse Observationer ere blevne reducerede til den sande Barometerstand, saaledes som den vilde være angivet af Normalbarometrene i St. Petersburg, Kew, Greenwich, Stockholm[1]. Middel af de tre daglige Observationer er antaget som Dagsmedium. Til nærværende Undersøgelse er brugt den 16-aarige Række fra 1867 til 1882.

Lignende Observationer ere benyttede fra Stationerne Oxø (1872 October til 1882 December), Florø (1869 August til 1882 December), Brønø (1869 August til 1882 December), Bodø (1867 December til 1882 December), Tromsø (1867 September til 1882 December), Alten (1871 April

[1] Om det norske meteorologiske Instituts Normalbarometer, se Jahrbuch des norwegischen meteorologischen Instituts für 1884; Vorwort, S. I til VII. De i min Afhandling "Meteorologi" i denne Generalberetning givne Barometerhøjder blive at corrigere med + 0.4 mm.

afford a good basis for continued research, and may, too, as a first approximation, be found to agree in all essential particulars with the true conditions in nature.

From the North Ocean we have divers observations on wind. But either they crowd together throughout particular tracts navigated by merchant-vessels, or they refer wholly to particular months in which the navigation takes place, so that extensive tracts and many months of the year are but sparsely represented by the results of an occasional Scientific Expedition or a few sealing ships, nay, some parts of the sea have never been visited either by seafarers in general or by men of science.

With such material, it would be quite out of the question satisfactorily to account for the normal conditions of the wind throughout the year.

We have, however, another mode of attacking the subject, which, with a probability greatly superior to that afforded by direct wind-observations, leads to the end in view. The meteorological investigations of the last decennial periods give, as their best founded result, the connection existing between the distribution of atmospheric pressure and the direction and velocity of the wind. And this law, the baric wind-law, applies — with respect to the strata of air nearest the earth — in its full rigour precisely to the phenomena at the surface of the sea.

Now, provided we can determine the distribution of atmospheric pressure over the sea for the normal year, we shall be able to deduce from thence with very considerable certainty the normal direction and velocity of the prevailing winds for the same period.

Accordingly, we commence our researches on ocean circulation by investigating the distribution of atmospheric pressure throughout the normal year.

For determining this distribution, I have made use of the following observations.

The Norwegian Meteorological Coast-Stations, viz., Christiania, Sandøsund, Mandal, Skudesnes, Bergen, Aalesund, Christiansund, and Vardø, furnish a complete series of observations for 8 a. m., 2 p. m., and 8 p. m., from the month of January 1867, taken with instruments constantly submitted to control. These observations have been reduced to the true height of the mercury as it would have been shown by the standard-barometers of St. Petersburgh, Kew, Greenwich, Stockholm.[1] The mean of the three daily observations has been taken as the diurnal mean. For the present investigation, I have adopted the sixteen-years series from 1867 to 1882.

Similar observations have been applied from the following Stations: — Oxø (1872 October to 1882 December), Florø (1869 August to 1882 December), Brønø (1869 August to 1882 December), Bodø (1867 December to 1882 December), Tromsø (1867 September to 1882 December),

[1] Respecting the Standard-Barometer of the Norwegian Meteorological Institute, see Jahrbuch des norwegischen meteorologischen Instituts für 1884. Vorwort, p. I to VII. The barometrical readings in my Memoir "Meteorology" published in this General Report must be increased with 0.4 mm.

til 1882 December), reducerede paa samme Maade som de ovenfor nævnte og til disses 16-aarige Række 1867 til 1882.

Ved Godhed af Captein Hoffmeyer, Bestyrer af det danske meteorologiske Institut, erholdt jeg de midlere maanedlige Barometerhøjder for Stykkisholm paa Island for Tidsrummet 1857 til 1877. Til disse føjedes, efter den danske meteorologiske Aarbog, Observationerne for 1878 til 1880, saa at der for Stykkisholm forelaa Barometerhøjder for den 24-aarige Række 1857 til 1880.

Efter den danske meteorologiske Aarbog beregnedes Middelbarometerhøjden for de islandske Stationer Akureyri paa Nordkysten og Berufjord paa Østkysten samt for Thorshavn paa Færøerne for Aarrækken 1874 til 1880. Disse 7-aarige Rækker reduceredes til Stykkisholms 24-aarige. For Thorshavns Vedkommende reduceredes ogsaa til Aalesunds 16-aarige Række, og toges Middel af begge Resultater.

For 3 Stationer i Danmark, Skagen, Fanø og Kjøbenhavn, toges Middelbarometerstanden af det danske meteorologiske Instituts Publicationer (Aarbog og Danmarks Klima).

De danske Observationer ere reducerede til Normalbarometret i Kjøbenhavn, der stemmer overens med Normalbarometrene i St. Petersburg og Kew.

De normale Barometerhøjder for Skotland og de skotske Øer ere tagne efter Buchans Afhandling i Journal of the Scottish Meteorological Society No. LVIV. De ere reducerede til Normalbarometret i Kew.

Fra Spidsbergen haves et Aars Observationer fra Nordenskiölds Overvintring i Mosselbay (A. Wijkander: Observations météorologiques de l'expédition arctique suédoise 1872—73) og fra Smiths Observatorium i Isfjorden (N. Ekholm: l'expédition suédoise au Spitzberg 1882—1883). Det svenske Normalbarometer i Stockholm er overenstemmende med det i St. Petersburg.

Fra Øst-Grønland har jeg benyttet Observationerne fra den anden tyske Nord-Polar-Expedition, der overvintrede ved Sabine-Øen 1869 til 70. (Zweite deutsche Nordfahrt II. K. Koldewey, 4, Luftdruck).

For Jan Mayen har jeg benyttet Observationerne fra den østerrigske Polar-Station 1882—83. (E. v. Wohlgemuth: Bericht etc.).

For Spidsbergen, Øst-Grønland og Jan Mayen har jeg kun benyttet Aarsmedierne.

Til Fuldstændiggjørelse af Kartet over det normale Lufttryk har jeg medtaget samtlige norske Barometerhøjder samt nogle svenske Stationer (Hamberg: Månadsöfversigt af Väderleken i Sverige) og nogle russiske (Wild: Ueber die Beziehungen zwischen Isobaren und Isanomalen der Temperatur).

For at finde den normale Barometerstand paa Havet har jeg benyttet Hoffmeyers synoptiske Karter, der for hver Dag Kl. 8 Morgen fra September 1873 til November 1876 give Barometerhøjdernes Fordeling over Nordhavet.

Alten (1871 April to 1882 December), reduced in the same manner as stated above, and likewise to the sixteen-years series 1867—1882.

By the courtesy of Capt. Hoffmeyer, Director of the Danish Meteorological Institute, I obtained the mean monthly heights of the barometer at Stykkisholm, Iceland, for the period 1857 to 1877. To these were added, from "Dansk meteorologisk Aarbog," the observations for 1878 to 1880; and hence I had for Stykkisholm observations of the barometer for the twenty-four-years series, viz., from 1857 til 1880.

From "Dansk meteorologisk Aarbog" was computed the mean height of the barometer for the Icelandic Stations: — Akureyri, on the north coast, and Berufjord on the east, as also for Thorshavn, on the Færoes, for the years ranging from 1874 to 1880. This seven-years series was reduced to Stykkisholm's twenty-four-years series. As regards Thorshavn, the reduction was also made to Aalesund's sixteen-years series, and a mean taken of the both results.

For 3 Stations in Denmark, viz., Skagen (the Scaw), Fanø, and Copenhagen, the mean height of the barometer was taken from the Publications of the Danish Meteorological Institute ("Aarbog" and "Danmarks Klima").

The Danish observations have been reduced to the Standard-Barometer of Copenhagen, which agrees with the Standard-Barometers of St. Petersburgh and Kew.

The normal heights of the barometer for Scotland and the Scottish Isles have been taken from Buchan's Memoir in "Journal of the Scottish Meteorological Society," No. LVIV. They are reduced to the Standard-Barometer of Kew.

For Spitzbergen we have a year's observations, from Nordenskiöld's wintering in Mossel Bay (A. Wijkander: Observations météorologiques de l'expédition arctique suédoise 1872—1873), and from Smith's Observatory in Ice Sound (N. Ekholm: L'expédition suédoise au Spitzberg 1882—1883). The Swedish Standard-Barometer in Stockholm agrees with that of St. Petersburgh.

For East Greenland, I have made use of the observations taken on the Second German North-Polar Expedition, that wintered on Sabine Island 1869—1870 (Zweite Deutsche Nordfahrt II. K. Koldewey, 4, Luftdruck).

For Jan Mayen, I have applied the observations from the Austrian Polar Station 1882—1883 (E. v. Wohlgemuth: Bericht etc.)

For Spitzbergen, East Greenland, and Jan Mayen, I have applied only the annual mean.

To complete the map showing the normal atmospheric pressure I took all the Norwegian barometric observations, as also those from a few Swedish Stations (Hamberg: Månadsöfversigt af Väderleken i Sverige), and a few Russian (Wild: Ueber die Beziehungen zwischen Isobaren und Isanomalen der Temperatur).

With the object of finding the normal height of the barometer at sea, I have employed Hoffmeyer's Synoptical Charts, that give for every day — 8 a. m. — from September 1873 to November 1876, the distribution of the height of the barometer over the North Ocean.

For hver af disse Dage udtoges af Karterne Barometerhøjden for en Række Punkter paa Havet, nemlig:

For each of these days, I took from the charts the height of the barometer for a series of points on the sea, viz.: —

Nord. Bredde (*Lat. N*)	60°	65°	60°	70°	60°	65°	70°	75°	60°
Længde f. Gr. (*Long. from Gr.*)	30° W	30° W	20° W	20° W	10° W	10° W	10° W	10° W	0°
Nord. Bredde (*Lat. N*)	65°	70°	75°	65°	70°	75°	75°	70°	70°
Længde f. Gr. (*Long. from Gr.*)	0°	0°	0°	10° E	10° E	10° E	20° E	40° E	50° E.

Af disse Tal beregnedes Maanedsmiddel for den Aarrække, hvori hver Maaned forekommer. (Januar til August 3 Aar, September til November 4 Aar, December 3 Aar).

For de tilsvarende Tidsrum beregnedes Maanedsmiddel af Barometerstanden for Stationerne Stykkisholm, Akureyri, Berufjord, Thorshavn, Mandal, Skudesnes, Bergen, Florø, Aalesund, Christiansund, Brønø, Bodø, Tromsø, Alten og Vardø. Disse Media for Epoken 1873—76 eller 1873—75 eller 1874—76 subtraheredes fra de normale Maanedsmedia efter den 24- eller 16-aarige Række. De fundne Differentser tjene til at reducere den kortvarige Række efter Karterne til Kyststationernes normale Værdier.

For Kyststationerne toges for Karternes Epoke Maanedsmiddel af Barometerhøjden Kl. 8 Morgen. Disse Medier subtraheredes fra de normale Maanedsmedia. Differentsen tjener til at reducere Karternes Observationer fra Kl. 8 a.m. til Dagsmediet.

Begge de saaledes udledede Correctioner for hver Kyststation sloges sammen.

Til Reduction af Barometerstanden paa en Hav-Station til den normale Barometerhøjde anvendtes i Regelen de tilsvarende Correctioner for flere Kyststationer, og disse gaves ved Beregningen af det endelige Resultat en Vægt, der var omvendt proportional med Afstanden mellem Hav-Stationen og den respective Kyst-Station.

Det var ikke muligt, for alle de ovennævnte Hav-Stationer, at erholde af de synoptiske Karter fuldstændige Observationsrækker. I saadanne Tilfælder har jeg completteret Rækkerne, dels ved at construere Karter for de enkelte Maaneder og udfylde Hullerne derefter, dels ved at construere Curver for hver Hav-Station, der viste Lufttrykkets normale aarlige Variation fra Maaned til Maaned, og paa den Maade interpolere de manglende Værdier. Disse Curver have ogsaa været særdeles nyttige for de complette Hav-Stationers Vedkommende til at controllere de udledede Normalværdier, idet deres almindelige Character maatte variere successivt langs Forbindelseslinierne mellem Kyststationerne paa begge Sider af Havet, og henimod Kysterne nærme sig til Kyststationernes.

Hav-Stationernes Barometerhøjder vare allerede reducerede til Havfladen. Land-Stationernes bleve reducerede til Havfladen, idet Hensyn toges til Lufttemperaturen.

Endelig reduceredes samtlige Barometerhøjder til absolut Lufttryk eller til den normale Tyngde (ved 45° Bredde og Havfladen) efter Formelen:

From these figures was computed the monthly mean for the series of years in which each month occurs. (January to August 3 years, September to November 4 years, December 3 years).

For the corresponding periods was computed the mean monthly height of the barometer for the Stations Stykkisholm, Akureyri, Berufjord, Thorshavn, Mandal, Skudesnes, Bergen, Florø, Aalesund, Christiansund, Brønø, Bodø, Tromsø, Alten, and Vardø. These means for the interval 1873—1876 or 1873—1875 or 1874—1876 were subtracted from the normal monthly means deduced from the twenty-four or the sixteen-years series. The differences thus found serve for reducing the short series of the charts to the normal values of the Coastal Stations.

For the Coastal Stations, were taken the monthly means of the height of the barometer at 8 a. m. for the period of the charts. These means were subtracted from the normal monthly means. The difference serves for reducing the observations in the charts from 8 a. m. to the daily mean.

Both the corrections thus deduced for every Coastal Station were added together.

For reducing the height of the barometer at a Sea-Station to the normal height, the corresponding corrections for several Coastal Stations were as a rule applied, and these were given, when computing the final result, a weight inversely proportional to the distance between the Sea-Station and the respective Coast-Station.

It was not possible to obtain for all the above-mentioned Sea-Stations complete series of observations from the Synoptical Charts. In such cases I completed the series myself, partly by constructing maps for the different months and then filling up the blanks, and partly by drawing curves for each Sea-Station that exhibited the normal annual variation from month to month of the atmospheric pressure, and thus interpolating the missing values. These curves have also proved exceedingly useful as regards the complete Sea-Stations, viz., in controlling the computed normal values, since their general character could not but vary successively along the lines of connexion between the Coastal Stations on both sides of the sea, and, in the vicinity of the coasts, approach that of the Coastal Stations.

The height of the barometer for the Sea-Stations had been already reduced to the sea-level. When reducing it for the Land-Stations to the sea-level, regard was had to the temperature of the air.

Finally, every height of the barometer was reduced to absolute atmospheric pressure, or to the normal gravity (45th parallel of latitude and sea-level), according to the formula: —

Absolut Lufttryk =

Barometerhøjden (1—0.00259 cos 2 φ) (1—0.000000196 H) hvor φ er Stedets Bredde og H Højden over Havet i Meter [1]. Tyngdecorrectionen varierer fra + 0.7 mm ved 50° Bredde til + 1.9 mm ved 80° Bredde, altsaa 1.2 mm fra Nordsøen til Nordspidsbergen. Denne Størrelse er ikke ringe i Forhold til de svage Lufttrykgradienter, hvormed vi have at gjøre i det normale Lufttryk over vort Nordhav.

Den følgende Tabel giver det saaledes udledede normale Lufttryk for de Kyst- og Hav-Stationer, der ere benyttede til Bestemmelsen af sammes aarlige Fordeling over Nordhavet.

Absolute Atmospheric Pressure =

Height of Barometer (1—0.00259 cos 2 φ)(1—0.000000196 H), in which φ denotes the latitude of the place and H the height above the sea in metres. [1] The gravity-correction varies from + 0.7 mm., in lat. 50° N, to + 1.9 mm., in lat. 80° N; thus, 1.2 mm. from the North Sea to North Spitzbergen. This difference is anything but slight compared to the small gradients of atmospheric pressure wherewith we have to deal in the normal atmospheric pressure prevailing over the North Ocean.

The following Table gives the normal *Atmospheric Pressure* thus found for the Coast and Sea-Stations, the results from which have been applied in determining the annual distribution of the pressure over the North Ocean.

	Mandal	Skudesnes	Bergen	Florø	Aalesund	Christiansund	Brønø	Bodø
Bredde (*Lat.*)	58° 2′	59° 9′	60° 24′	61° 36′	62° 28′	63° 7′	65° 28′	67° 17′
Længde (*Long.*)	7 27 E.	5 16 E.	5 20 E.	5 2 E.	6 10 E.	7 14 E.	12 13 E.	14 24 E.
Januar	760.6	759.3	758.2	757.5	756.4	756.3	755.8	754.9
Februar	59.6	58.6	57.6	57.0	56.0	55.8	55.2	54.3
Marts	59.1	58.6	57.9	57.5	56.6	56.5	56.0	55.2
April	59.7	59.6	59.0	59.3	59.0	58.9	58.6	58.1
Maj	61.0	61.2	60.5	60.6	60.4	60.6	60.3	60.1
Juni	60.0	60.2	59.8	59.8	59.7	59.9	59.8	59.5
Juli	58.9	58.9	58.5	58.4	58.3	58.5	58.4	58.2
August	58.7	58.5	58.0	58.0	58.0	58.2	58.3	58.0
September	58.9	58.4	57.9	57.8	57.4	57.4	57.2	56.8
October	58.5	57.9	57.2	56.8	56.2	56.3	56.4	56.1
November	57.7	57.2	56.5	56.3	55.7	55.6	55.5	55.1
December	58.0	57.0	56.3	55.9	54.9	54.9	54.8	54.5
Aar (*Year*)	759.2	758.8	758.1	757.9	757.4	757.4	757.2	756.7

	Tromso	Alten	Vardø	Stykkisholm	Akureyri	Berufjord	Thorshavn
Bredde (*Lat.*)	69° 39′	69° 58′	70° 22′	65° 5′	65° 40′	64° 40′	62° 3′
Længde (*Long.*)	18 58 E.	23 15 E.	31° 8 E.	22 46 W.	18 8 W.	14° 15 W.	6 44 W.
Januar	753.3	754.5	754.0	747.3	749.2	750.1	752.7
Februar	53.0	54.2	53.4	50.2	51.5	51.8	53.3
Marts	54.0	54.8	53.9	54.9	56.1	56.5	56.3
April	57.5	58.0	57.2	57.8	58.9	58.5	58.1
Maj	60.1	60.8	60.5	60.2	60.8	61.0	60.8
Juni	59.4	59.8	59.3	57.6	58.0	58.0	58.9
Juli	58.4	58.5	58.8	57.1	57.1	57.0	57.6
August	58.0	58.1	58.2	57.1	57.5	57.8	57.9
September	56.2	56.9	56.6	54.7	55.3	55.1	56.0
October	55.6	55.9	55.3	53.4	54.2	53.4	54.0
November	54.0	55.3	54.4	56.3	58.5	57.8	56.2
December	53.6	55.1	54.2	50.2	51.7	51.8	52.7
Aar (*Year*)	756.1	756.8	756.3	754.7	755.7	755.7	756.2

[1] O. J. Broch. Accélération de la pesanteur. Mémoirs du bureau international des poids et mesures.

Bredde (*Lat.*)	60°	65°	60°	70°	60°	65°	70°	75°	60°
Længde (*Long.*)	30° W.	30° W.	20° W.	20° W.	10° W.	10° W.	10° W.	10° W.	0°
Januar	746.0	746.3	749.9	751.0	752.5	749.0	751.0	753.6	755.1
Februar	48.1	48.7	50.1	54.4	54.2	50.0	52.6	55.6	56.3
Marts	53.2	55.5	55.2	58.6	56.0	55.8	57.1	60.1	56.1
April	55.5	58.1	58.3	62.2	58.5	58.0	60.0	64.2	59.3
Maj	58.0	59.3	59.9	62.5	60.5	61.0	62.1	64.2	60.4
Juni	57.0	57.0	56.7	59.8	59.0	57.8	58.9	60.4	60.4
Juli	57.4	57.7	57.5	58.7	58.4	57.2	58.0	59.3	58.4
August	56.4	57.1	57.3	58.4	58.3	57.4	58.1	59.3	58.3
September	54.1	54.8	55.0	56.5	55.9	55.3	56.0	58.7	56.5
October	53.1	54.7	53.2	57.2	54.2	53.3	55.5	58.5	55.4
November	53.7	56.1	55.4	60.8	56.7	57.6	60.0	62.5	56.7
December	48.8	50.0	52.6	56.2	54.0	51.7	53.7	56.1	55.2
Aar (*Year*)	753.4	754.6	755.1	758.0	756.5	755.3	756.9	759.4	757.3

Bredde (*Lat.*)	65°	70°	75°	65°	70°	75°	75°	70°	70°
Længde (*Long.*)	0°	0°	0°	10° E.	10° E.	10° E.	20° E.	40° E.	50° E.
Januar	751.5	750.3	752.9	755.2	752.2	752.7	752.8	755.0	755.8
Febrar	53.8	52.3	55.1	55.2	52.1	53.8	53.9	54.1	56.9
Marts	56.7	57.1	58.4	55.8	54.0	56.0	56.2	54.3	57.2
April	57.9	58.3	61.1	58.5	57.5	58.3	58.7	57.4	60.3
Maj	60.2	59.7	62.3.	60.2	59.0	59.9	60.0	60.9	63.2
Juni	58.1	58.1	60.1	59.7	58.4	58.7	58.8	59.2	59.7
Juli	56.9	56.3	58.3	58.3	57.1	57.7	57.7	59.2	60.4
August	57.6	58.0	58.8	58.1	57.5	57.7	57.7	58.3	59.8
September	56.7	57.1	58.3	57.2	56.2	57.4	56.8	57.5	59.5
October	53.1	53.9	55.8	56.1	53.7	56.1	55.1	56.2	57.0
November	55.2	57.2	60.2	55.1	54.5	58.1	56.7	55.5	57.2
December	52.1	53.6	55.3	54.8	54.2	55.4	54.2	56.2	58.4
Aar (*Year*)	755.8	756.0	758.1	757.0	755.5	756.8	756.6	757.0	758.8

	Mosselbay.	Smiths Obs.	Sabine I.	Jan Mayen.
Bredde (*Lat.*)	79° 53′	78° 28′	74° 32′	70° 59′
Længde (*Long.*)	16 4 E	15 43 E	18 50 W	8 28 W
Aar (*Year*)	761.1	760.1	760.6	757.3

Afsættes disse samt de skotske og danske Observationer paa et Kart, finder man, at der i alle Maaneder ligger et Lufttryk-Minimum over det norske Hav[1]. Det, som her interesserer os mest, er det normale Lufttryk for Aaret. Dette er fremstillet ved Hjelp af Isobarer i Pl. XXXI. I dette Kart ere samtlige benyttede Observationer indtegnede. De Tal paa Havet, der ikke hore til de ovennævnte Stationer, ere udledede af Maanedsmedia, fundne ved Hjelp af Maanedskarter og controllerede ved Curver for den aarlige Variation.

I Sydvest for Island finde vi det bekjendte Grønlandsk-Islandske Lufttryk-Minimum med et Lufttryk af under 754 mm. Imellem Sydost-Enden af Island og den sydlige Del af Østhavet ligger et langstrakt Lufttrykminimum, om-

[1] En udførligere Fremstilling af Lufttrykkets Fordeling over Nordvest-Europa og Nordhavet har jeg givet i Zeitschrift der österreichischen Gesellschaft für Meteorologie 1884, S. 145. Med Karter. Man observere Berigtigelserne i samme Tidsskrift S. 303 og for 1885 S. 32, samt Jahrbuch des norwegischen meteorologischen Instituts für 1884, Vorwort, S. VI og VII. samt Jahrbuch für 1885, Vorwort. Tallene i ovenstaaende Tabel ere corrigerede efter alle bekjendte Correctioner, efterat Kartet, Pl. XXXI, var trykt.

Now if these observations, together with the Scottish and Danish, are set down on a map, a minimum of atmospheric pressure will be found to extend during every month of the year above the Norwegian Sea.[1] That with which we here have specially to deal is the normal atmospheric pressure for the year. It is represented by means of isobars in Pl. XXXI. The map gives all observations made use of. The figures for the sea not belonging to the fore-mentioned Stations, have been educed from monthly media found by means of monthly maps and controlled by curves for the annual variation.

South-west of Iceland, occurs the well-known Greenland-Icelandic minimum, with a pressure of somewhat less than 754 mm. Between the south-eastern extremity of Iceland and the southern part of the Barents Sea, we have

[1] A more detailed account of the distribution of atmospheric pressure over North-western Europe and the North Ocean, I have given in Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, p. 145. With Maps. Attention is called to the rectification of errors in that volume of the Periodical, p. 303, and in that for 1885 p. 32; as also to Jahrbuch des norwegischen meteorologischen Instituts für 1884, preface, pp. VI and VII; and to Jahrbuch für 1885, preface. The numbers in the above Table were corrected for all known errors after the Map, Pl. XXXI, had been printed.

grændset af Isobaren for 755.6 mm. Indenfor denne findes to partielle Minima, et østenfor Island, hvor Lufttrykket gaar ned til lidt under 755.3 mm, og et vestenfor Nordkap, hvor det laveste Lufttryk netop naar denne Værdi. Mellem disse Minima stiger Lufttrykket ikke højere end til henimod 755.6 mm, paa 67°.5 N. Br. og 0° Lgde. Den østlige Del af Island danner en barometrisk Højderyg paa 755.7 mm mellem det grønlandsk-islandske og det norske Havs Minima. Imellem Nordgrønland og Nordspidsbergen gaar Lufttrykket op til over 761 mm. Det samme Lufttryk findes i det sydøstre Hjørne af Kartet i Øst-Preussen og Rusland. I den centrale Del af den skandinaviske Halvø er der et secundært Maximum paa 759.5 mm.

2. Vinden.

For at finde den midlere eller resulterende Retning og Hastighed af Vinden paa vort Nordhav har jeg benyttet følgende Formler, der udtrykke den bariske Vindlov[1]. Er:

G den barometriske Gradient, udtrykt i Millimeter absolut (reduceret til Normaltyngden) Kviksølvhøjde ved 0°, per midlere Meridiangrad eller 111 Kilometer (10 000 000 m : 90 = 111.111 Kilometer),

$\mu = 13.59593 \frac{90}{10\,000\,000} = 0.00012236$ [$\log \mu = 6.08765$], en Factor, der reducerer Gradienten til Trykforskjel i Kilogram (Normaltyngde) per Kvadratmeter (13.59593 er Kviksølvets specifiske Vægt ved 0°),

ϱ Massen af en Kubikmeter Luft eller det af Tyngden foraarsagede Tryk af en Kubikmeter Luft paa et horizontalt Underlag, divideret med Tyngdens Acceleration,

α Vindens Afbøjningsvinkel, regnet fra Gradientens Retning,

ω Jordens Omdrejningshastighed = $2\pi : 86164.09 = 0.00007292$ [$\log 2\omega = 6.16388$],

v Vindens Hastighed i Meter per Secund,

k Frictionscoefficienten,

φ den geografiske Bredde,

har man følgende Formler:

$$\frac{\mu}{\varrho} G \sin\alpha = 2\,\omega\, v \sin\varphi$$

$$\frac{\mu}{\varrho} G \cos\alpha = k\, v$$

$$\operatorname{tang}\alpha = \frac{2\,\omega \sin\varphi}{k}$$

[1] Études sur les mouvements de l'atmosphère par C. M. Guldberg et H. Mohn, S. 20. Zeitschrift der østerreichischen Gesellschaft für Meteorologie, 1877, S. 52. Sprung, Lehrbuch der Meteorologie, S. 120.

an elongated minimum, bounded by the isobar for 755.6 mm. Within this isobar, occur two partial minima, one east of Iceland, where the atmospheric pressure goes down to a little under 755.3 mm., and one west of the North Cape, where the lowest atmospheric pressure just reaches that value. Betwixt these minima, the pressure does not rise higher than about 755.6 mm. in lat. 67°.5 N and long. 0°. The eastern tract of Iceland constitutes a barometrical ridge, with a pressure of 755.7 mm., extending between the Greenland-Icelandic and the Norwegian-Sea minima. Again, between North Greenland and North Spitzbergen, the pressure reaches upwards of 761 mm. An equal atmospheric pressure occurs in the south-eastern corner of the map, viz., in East Prussia and Russia. Over the central region of the Scandinavian peninsula, occurs a secondary maximum, with a pressure of 759.5 mm.

2. The Wind.

In order to find the mean or resulting direction and velocity of the wind throughout the North Ocean, I have made use of the following formulæ, that express the baric wind-law.[1] Let

G be the barometrical gradient, expressed in millimetres and absolute (with reduction to normal gravity) height of mercury at 0°, per one mean degree of meridian, or 111 kilometres (10 000 000 m. : 90 = 111.111 kilometres);

$\mu = 13.59593 \frac{90}{10\,000\,000} = 0.00012236$ [$\log \mu = 6.08765$], a factor which reduces the gradient to difference of pressure in kilogrammes (normal gravity) on a square metre (13.59593 = the specific gravity of mercury at 0°);

ϱ the mass of a cubic metre of air, or the pressure caused by the weight of a cubic metre of air on a horizontal base divided by the acceleration of gravity;

α the wind's angle of deviation, computed from the direction of the gradient;

ω the earth's velocity of rotation = $2\pi : 86164.09 = 0.00007292$ [$\log 2\omega = 6.16388$];

v the velocity of the wind, in metres per second;

k the friction-coefficient;

φ the latitude;

and we have the following formulæ: —

$$\frac{\mu}{\varrho} G \sin\alpha = 2\,\omega\, v \sin\varphi$$

$$\frac{\mu}{\varrho} G \cos\alpha = k\, v$$

$$\tan\alpha = \frac{2\,\omega \sin\varphi}{k}$$

[1] Études sur les mouvements de l'atmosphère par C. M. Guldberg et H. Mohn, p. 20. Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, p. 52. Sprung, Lehrbuch der Meteorologie, p. 120.

$$r = \frac{\frac{\mu}{\varrho} G \sin \alpha}{2\, \omega \sin \varphi} = \frac{\frac{\mu}{\varrho} G \cos \alpha}{k}$$

Disse Formler gjælde strengt taget kun for det Tilfælde, at man har retliniede, æquidistante Isobarer og jevn Bevægelse. Af Kartet, Pl. XXXI, vil man se, at disse Betingelser temmelig nær tilfredsstilles for store Strækninger af Nordhavet. Centrifugalkraften, der nærmest skulde blive virksom i Østhavet, bliver ringe, da Vindens Hastighed paa de respective Steder ikke er stor. Da, som senere skal vises, Vindens Virkning ikke overalt directe kan overføres paa Havets Bevægelse, bliver den exacte Bestemmelse af Vindens Retning og Hastighed af mindre Betydning. Jeg har derfor anvendt de ovenstaaende Formler uden Modification.

Gradienten er taget af Isobarerne paa Kartet Pl. XXXI. Ved Hjelp af Tversnit, lagte lodret paa Isobarerne, eller i Gradientens Retning, i hvilke 10 mm i vertical Retning forestillede en Lufttrykforskjel af 1 mm, og Grundlinien havde Kartets Maalestok, bestemtes Beliggenheden af Isobaren for hver Tiendedel Millimeter og indtegnedes i Arbejdskartet. Dernæst construeredes paa Millimeterpapir en Skala, der med Argument (i horizontal Retning): Afstand paa Kartet gav som Function (i vertical Retning, Gradient af 1 mm = Ordinat paa 100 mm.): den tilsvarende Gradient. Da Gradientens Størrelse er omvendt proportional med Isobarernes indbyrdes Afstand, havde denne Skala Form af en ligesidet Hyperbel. Ved at udmaale paa Kartet Afstanden mellem Isobarerne for en Lufttrykforskjel af 1 mm, der svarer til det Punkt, for hvilket man vil beregne Vindens Retning og Hastighed (10 Gange Afstanden mellem Isobarerne for 0.1 mm), afsætte denne Afstand som Abscisse paa Skalaen, og søge Størrelsen af den dertil svarende Ordinat, finder man i denne den søgte Størrelse af Gradienten.

Størrelsen ϱ, Massen af en Kubikmeter Luft, bestemmes paa følgende Maade. Ved det absolute Lufttryk 760 mm, 0° og Normaltyngden vejer et Kilogram tør Luft[1] 1.293052 Kilogram. Sættes Normaltyngden (45° Bredde, Havets Overflade) efter Listing til 9.806165 bliver Massen af en Kubikmeter Luft under de anførte Forhold

$$\varrho_0 = \frac{1.293052}{9.806165} = 0.1318611$$

Er det absolute Lufttryk b mm, Luftens Temperatur t^0 C., og indeholder den Vanddamp af e mm Tryk, bliver

$$r = \frac{\frac{\mu}{\varrho} G \sin \alpha}{2\, \omega \sin \varphi} = \frac{\frac{\mu}{\varrho} G \cos \alpha}{k}.$$

These formulæ apply in a strict sense only for rectilinear, equidistant isobars and a uniform motion. From the map, Pl. XXXI, we see that full compliance with such conditions is nearly found for extensive tracts of the North Ocean. Centrifugal force, which might be assumed to exert its chief influence in the Barents' Sea, is but trifling, the wind having no great velocity in the respective localities. But since, as will subsequently appear, the effect of the wind cannot be everywhere transferred direct to the motion of the sea, the exact determination of the wind's direction and velocity is of less moment. I have therefore applied the above-given formulæ without modification.

The gradient has been taken from the isobars in the map, Pl. XXXI. By means of transverse sections, laid perpendicular to the isobars, or in the direction of the gradient, in which 10 mm. in a vertical direction represented a difference in atmospheric pressure of 1 mm. and in which the scale of the base was that of the map, the position of the isobar was determined for every tenth of a millimetre and marked off in the working-map. I then constructed on ruled paper a scale, which, with argument (horizontal direction): distance on map, gave as function (vertical direction, gradient of 1 mm. = ordinate of 100 mm.): the corresponding gradient. The magnitude of the gradient being inversely proportional to the respective distances between the isobars, this scale had the form of an equilateral hyperbola. By measuring out on the map the distance between the isobars for a difference in pressure of 1 mm., that corresponds to the point for which the direction and velocity of the wind has to be computed (10 times the distance between the isobars for 0.1 mm.), then setting off this distance as an abscissa on the scale and seeking the magnitude of the corresponding ordinate, we shall find therein the required value of the gradient.

The quantity ϱ, or the mass of a cubic metre of air, was determined in the following manner. At the absolute pressure 760 mm., 0°, and the normal gravity, one kilogramme of dry air[1] weighs 1.293052 kilogramme. Now, if we put the normal gravity (lat. 45°, sea-level), according to Listing, at 9.806165, the mass of a cubic metre of air under the said conditions will be —

$$\varrho_0 = \frac{1.293052}{9.806165} = 0.1318611.$$

Assuming the absolute pressure at b mm., the temperature of the air at t^0 C., and the latter to contain aqueous vapour of e mm. pressure, then

$$\varrho = \varrho_0 \, \frac{b - 0.3779\, e}{760} \cdot \frac{1}{1 + 0.00367\, t} = \varrho_0 \, \frac{b - 0.3779\, e}{760} \cdot \frac{273}{373 + t} = 0.047366 \, . \, \frac{b - 0.3779\, e}{273 + t} \, .$$

[1] O. J. Broch. Poids du litre d'air atmosphérique. Travaux et mémoires du comité international des poids et mesures.

Lufttrykket b har jeg taget efter Kartet Pl. XXXI, Luftens Temperatur t efter et Kart over Aarsisothermerne, som jeg har publiceret paa et andet Sted[1]. Idet jeg efter Observationerne fra vor Nordhavs-Expedition[2] sætter den relative Fugtighed til 88 Procent, bliver, naar E er den til Temperaturen t svarende Maximumspændkraft[3], $0.3779\ e = 0.3779 \times 0.88\ E = \frac{1}{3}\ E$, og man faar

$$\varrho = 0.047366. \frac{b - \frac{1}{3}E}{273 + t}; \quad \log 0.047366 = 8.67547.$$

Frictionscoeffienten k sætter jeg for det aabne Hav med moderat Søgang lig 0.000035[4].

For den Del af Havet, der er belagt med Is, stiller Forholdet sig anderledes, idet Hav-Isens ujevne Overflade gjør en større Modstand mod Luftens Bevægelse end selv det sterkest oprørte Hav.

Scoresby siger herom[5]:

"Naar Vinden blæser sterkt henover en sammenhængende Pakis eller et Isflak, bliver dens Kraft meget formindsket paa nogle faa Miles Vej. Saaledes kan en Storm ofte blæse flere Timer paa den ene Side af et Flak, førend den merkes paa den anden, eller, medens der blæser en Storm i aabent Vande, ville Skibe i Besæt inden Synsvidde føle kun dens halve Styrke".

Paa det aabne Hav er Forholdet $v:G$ omtrent ligt 7. For den isdækkede Del af Nordhavet sætter jeg det til 5. Dette svarer, som det vil sees af de nys citerede Steder, til en Frictionscoefficient af 0.00008, eller den, som er fundet for Nordamerika. Isgrændsen sætter jeg mellem Isothermerne for 0^0 og $+ 1^0$ paa Kartet Pl. XVI, saavel i Østhavet som i Grønlandshavet.

Efter disse Formler og Constanter er Vindens Retning og Hastighed beregnet for et stort Antal Punkter, jevnt fordelte over Nordhavet. Resultaterne afsattes i et Kart, paa hvilket der blev optrukket Pile i Vindens Retning og Linier for ligestor Vindhastighed. Over det aabne Hav er Vindens Afbøjningsvinkel omkring 75^0, over Isen er den omkring 60^0. Paa det første Sted danner Vinden en Vinkel af 15^0 med Isobaren, paa det andet 30^0. Kartet, Pl. XXXI, viser det resulterende Vindsystem. Pilene flyve i Vindens Retning. Antallet af Fjer paa Pilene angiver Hastigheden i Meter pr. Secund. Ingen Fjer, men en Spids paa Pilen, betegner en Hastighed af mindre end 0.5 Meter. Ved Stationerne paa Island, Færøerne og Fyr-Stationer paa Norges Kyst er, ved tykkere Pile med Spids, angivet Retningen af den i Aarets Løb hyppigste Vind.

[1] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, Aprilheft.

[2] Den norske Nordhavs-Expedition. H. Mohn. Meteorologi, S. 121, fgg.

[3] Broch. Tension de la vapeur d'eau. Travaux etc.

[4] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, S. 53 og 58. Sprungs Meteorologie, S. 121 og 123.

[5] An Account of the Arctic Regions, I, S. 296 og 297.

The pressure, b, I took from the map, Pl. XXXI, the temperature of the air, t, from a map of the isotherms for the year, that I have published elsewhere.[1] Now putting, in accordance with the observations from the North-Atlantic Expedition,[2] the relative humidity at 88 per cent, then, assuming E as the maximum-tension corresponding to the temperature t,[3] $0.3779\ e = 0.3779 \times 0{,}88\ E = \frac{1}{3}\ E$, and we have —

$$\varrho = 0.047366. \frac{b - \frac{1}{3}E}{273 + t}; \quad \log 0.047366 = 8.67547.$$

For the open sea, when moderately agitated, I put the friction-coefficient, k, at 0.000035.[4]

As regards the part of the ocean covered with ice, the case is different, the rough surface of sea-ice exerting a greater resistance to the motion of the air than does even the most agitated sea.

Scoresby remarks on this subject[5]: —

"When the wind blows forcibly across a solid pack or field of ice, its power is much diminished ere it traverses many miles: Insomuch, that a storm will frequently blow for several hours on one side of a field, before it be perceptible on the other; and, while a storm prevails in open water, ships beset within sight, will not experience one-half of its severity."

Out at sea, the ratio $v:G$ is about equal to 7. For the ice-covered part of the North Ocean, I put it at 5. This corresponds, as will appear from the passages in the works cited above, to a friction-coefficient of 0.00008, or that found for North America. The ice-limit I put between the isotherms for 0^0 and $+ 1^0$, as given on the map, Pl. XVI, both in the Barents Sea and in the Greenland Sea.

From these formulæ and constants, the direction and velocity of the wind has been computed for a great number of points, uniformly distributed over the North Ocean. The results I set down in a map, on which arrows were drawn in the direction of the wind, and lines for equal velocity of the wind. Over the open sea, the wind's angle of deviation is about 75^0, over the ice it is about 60^0. Over the open sea, the wind forms with the isobar an angle of 15^0, over the ice an angle of 30^0. The map, Pl. XXXI, exhibits the resulting wind-system. The arrows fly in the direction of the wind. The number of feathers on an arrow indicate the velocity in metres per second. No feather at all, but merely a point, denotes a velocity of less than 0.5 metre. At the Stations on Iceland, the Færoes, and some Lighthouse-Stations along the coast of Norway, thicker

[1] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, Aprilheft.

[2] The Norwegian North-Atlantic Expedition. H. Mohn. Meteorology, p. 121, and following.

[3] Broch. Tension de la vapeur d'eau. Travaux etc.

[4] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, pp. 53 and 58. Sprungs Meteorologie, pp. 121 and 123.

[5] An Account of the Arctic Regions, Vol. I, pp. 296 and 297.

Den falder, i det Hele taget, i nogenlunde samme Retning som den normale Vind paa Havet; men der er ogsaa Afvigelser, saaledes som man kan vente, da Resultanten af alle Aarets Vinde ikke behøver at falde sammen med Retningen af den Vind, der er den hyppigste.

De sterkeste Vinde træffe vi i de nordlige Dele af Østhavet og af Grønlandshavet samt i Nordsøen, de svageste ved Lufttrykkets Minimum. I de to Minima samt i det secundære Maximum søndenfor Island (63° N. 14° W.) er der Vindstille. Ved Isgrændsen er der secundære Maxima af Vindhastighed. Søndenfor Lufttrykminimet herske sydvestlige Vinde over en Trekant mellem Island, Skotland og Nordkap. I de polare Dele af Havet herske nordlige og østlige Vinde.

arrows, with a point, show the direction of the most prevalent wind during the course of the year. On the whole, it takes much the same direction as the normal wind at sea, though differences are found to occur, as indeed we have reason to expect, since the resultant of all the winds of the year need not have the same direction as the wind which is the most frequent.

The strongest winds are met with in the northern parts of the Barents Sea and of the Greenland Sea, as also in the North Sea, the lightest in the locality of the minimum of pressure. In the two minima and the secondary maximum south of Iceland (lat. 63° N, long. 14° W), there is a calm. At the ice-limit, occur secondary maxima of wind-velocity. South of the minimum of pressure, south-westerly winds prevail over a triangular tract extending between Iceland, Scotland, and the North Cape. In the Arctic parts of the ocean, the prevailing winds are northerly and easterly.

3. Vind-Strømmen.

Den Hastighed, som en Vind af en vis Styrke, ved at blæse i længere Tid, er istand til at give Vandet i Havets Overflade, har jeg søgt at finde ved at studere de righoldige Data, der ere givne i de af Meteorological Office i London udgivne Verker: Charts of Meteorological Data for Square 3. Lat. 0°—10° N, Long. 20°—30° W og Charts of Meteorological Data for nine, ten degree Squares Lat. 20° N—10° S, Long. 10°—40° W. I disse Felter af det æquatoriale Atlanterhav blæse nemlig Passatvindene med den ønskelige Stadighed i Retning og Styrke, og begge Grene af Æquatorialstrømmen, den nordlige og den sydlige, løbe med betydelig Hastighed, for en stor Del i de herskende og stadige Vindes Retning. Som vi senere skulle se, er Havstrømmens Hastighed afhængig, foruden af de herskende Vinde, ogsaa af Fordelingen af den specifiske Vægt i Havet, der kan foranledige Afvigelser i Havoverfladen fra Niveaufladen, og saaledes fremkalde Strømninger. Hertil har jeg ved nærværende Undersøgelse ikke kunnet tage fuldt Hensyn. Imidlertid maa det bemerkes, at den Virkning, de ulige specifiske Vægter have til at frembringe Strøm, er ringe i Forhold til Vindens Virkning — undtagen under Kysterne, hvor Elvene udgyde sit ferske Vand over det salte Havs Overflade — og saaledes i Æquatorialegnene, hvor de constante Vindes Hastighed er stor (10 m. mod højst 4 m. p. S. i Nordhavet), af underordnet Betydning. Hertil kommer, at Sammenligningen mellem Strømmens Hastighed og Vindens Hastighed i Æquatorialegnene ikke kan gjøres directe, idet den sidste først maa udledes af den observerede Vind-Styrke efter Beaufort-Skalaen. Herved opstaar en Usikkerhed, der turde være af samme Orden som den, Undladelsen af at tage Hensyn til de specifiske Vægter medfører. Forøvrigt fører Betragtningen af Guineastrømmen, der med sin østgaaende Bevægelse paa den nordlige Halvkugle antyder en Depression af Havoverfladen svarende i Beliggenhed til det

3. The Wind-Current.

The velocity which a wind of a given force is enabled, by blowing for any length of time, to give the water of the surface of the sea, I have sought to determine by studying the copious supply of data furnished in the publications of the Meteorological Office in London, viz.: — "Charts of Meteorological Data for Square 3: lat. 0°—10° N, long. 20°—30° W;" and "Charts of Meteorological Data for nine ten-degree Squares: lat. 20° N—10° S, long. 10°—40° W." Throughout these tracts of the Equatorial Atlantic, the trade-winds are namely found to blow with the requisite constancy in direction and force, and both branches of the Equatorial Current, the north and the south, flow with considerable rapidity, taking in a great measure the direction of the prevailing and steadily-blowing winds. As will afterwards be shown, the velocity of the ocean-current depends, apart from the influence of the prevailing winds, also on the distribution of the specific gravity of the sea-water, which can occasion deviations in the sea-surface from the surface of level, and thus give rise to currents. To this circumstance, however, I could not take full regard on the present occasion. Meanwhile, we must bear in mind that the influence unequal specific gravity exerts in producing currents is but slight as compared with the influence of the wind — save near the coast, where the rivers empty their fresh water over the surface of the salt sea — and thus in the equatorial regions, where the velocity of the constant winds is great (10 m. as contrasted with at most 4 m. per sec. in the North Ocean), has but subordinate importance. Moreover, the comparison between the rate of the current and the velocity of the wind cannot be made direct in the equatorial regions, since the latter of the two must first be educed from the force of the wind, observed according to Beaufort Scale. This gives rise to an uncertainty, possibly of the same order as that resulting from the omission to

æquatoriale Stillebeltes Lufttrykdepression, til det Resultat, at Virkningen af de ulige specifiske Vægter paa Strommens Hastighed forøger denne sondenfor Æquator i Square 301, 302 og 303, og formindsker den nordenfor Æqvator i Square 38, 39 og 40, hvad der ogsaa harmonerer med Tallene i den følgende Tabel, idet samme Vindstyrke sondenfor Æquator giver en storre Hastighed end nordenfor. Herved compenseres tildels Virkningerne i Middeltallet.

pay regard to specific gravity. For the rest, a consideration of the Guinea Current, which, with its easterly course on the northern hemisphere, indicates a depression of the sea-level corresponding in position to the barometric depression of the equatorial calm belt, leads to the result that the effect of the unequal specific gravities on the velocity of the current increases that velocity south of the equator in Squares 301, 302, and 303, and decreases it north of the equator in Squares 38, 39, and 40; nay, this is found to agree with the figures in the following Table, since the same force of wind south of the equator imparts a greater velocity than north of it. Thus the various effects are to some extent compensated in the mean result.

Af Diagrammerne i Meteorological Data udtoges de Tilfælder, da den midlere Vindretning og den midlere Stromretning vare overensstemmende eller næsten overensstemmende, og noteredes Vindens midlere Styrke efter Beaufort Skala samt Strommens midlere Hastighed i Kvartmile (60 à 1 Grad) i 24 Timer. Af disse Talrækker toges Middel for hver Maaned. Disse Media ere opforte i den følgende Tabel samt Antallet (N) af Tilfælder, af hvilke de ere beregnede.

From the Diagrams in "Meteorological Data," I extracted all cases showing the mean direction of the wind and the mean direction of the current to coincide or to almost coincide, and noted the mean force of the wind according to Beaufort Scale (W), as also the mean rate of the current in nautical miles (60 to 1 degree) per twenty-four hours (C). Of these series of figures, I took the mean for every month. These means are given in the following Table, together with the number (N) of cases from which they were computed.

Square	38. 39. 40.			2. 4.			3.			301. 302. 303.			Square
Bredde.	10°—20° N.			0°—10° N.			0°—10° N.			0°—10° S.			Latitude
	Vind	Strom	N.	Vind	Strom	N.	Vind	Strøm	N.	Vind	Strøm	N.	
Januar	4.8	11	18	3.4	20	8	3.2	14	17	4.0	15	20	January
Februar	4.3	11	18	3.5	15	10	3.3	14	18	3.8	15	12	February
Marts	4.3	10	16	3.4	15	12	3.1	12	13	3.5	15	13	March
April	4.2	11	18	3.8	16	11	3.0	16	12	3.4	15	20	April
Maj	4.4	10	19	3.2	16	9	3 0	14	14	4.0	16	21	May
Juni	4.3	12	19	3.3	21	10	3.5	21	9	4.3	17	20	June
Juli	3.8	12	18	3.8	24	8	3.6	21	7	4.4	18	20	July
August	3.6	13	12	3.9	23	7	4.0	19	10	4.4	16	19	August
September	3.7	12	13	3.5	17	4	3.3	16	10	4.5	16	19	September
October	3.9	12	16	3.3	15	8	3.5	13	6	4.4	14	16	October
November	3.8	12	16	3.9	19	9	3.7	14	8	4.3	14	16	November
December	4.3	11	15	2.7	18	7	3.4	14	18	4.2	15	19	December
Aar	4.1	11	198	3.5	18	103	3.3	15	142	4.1	16	215	Year
	W.	C.	N.	W.	C.	N.	W.	C.	N.	W.	C.	N.	

Tages Middel af Tallene i Horizontalrækken "Aar", idet de gives Vægt efter Antallet af Tilfælder, faar man, at en Vindstyrke efter Beaufort Skala af 3.9 giver en Stromhastighed af 15 Kvartmil i 24 Timer. Antallet af de Tilfælder, der ere benyttede til Beregningen, er 658.

Now, if we take the mean of the figures in the horizontal series, "Year," giving them weight in proportion to the number of cases, the result will be, that a wind of a force according to Beaufort Scale of 3.9 produces a velocity of current equal to 15 nautical miles in 24 hours. The number of cases made use of for the computation is 658.

For at omgjøre Vindstyrken efter Beaufort Skala til Vindhastighed har jeg benyttet Scotts Tabel[1]. Efter denne svarer en Vindstyrke af 3 til en Hastighed af 18 miles an

In order to convert the force of the wind according to Beaufort Scale to its velocity, I had recourse to Scott's Table.[1] According to this Table, a wind-force of 3

[1] An Attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort Scale), with some Remarks etc. by Robert H. Scott, F. R. S. Quarterly Journal of the Meteorological Society. Vol. II, No. 11, S. 114.

[1] An Attempt to establish a Relation between the Velocity of the Wind and its Force (Beaufort Scale), with some Remarks, etc., by Robert H. Scott, F. R. S. Quarterly Journal of the Meteorological Society, Vol. II, No. 11, p. 114.

hour og en Hastighed af 4 til 23 miles. Heraf beregnes, at Vindstyrken 3.9 svarer til 22.5 miles an hour. Da 1 mile an hour svarer til 0.447 Meter pr. Secund, faar man

Vindstyrke 3.9 = 10.0 Meter per Secund,

altsaa: til en Vindhastighed af 10.0 m. p. S. svarer en Strømhastighed af 15 Kvartmil i 24 Timer eller, idet vi sætte Strømhastigheden proportional med Vindhastigheden,

Vindhastighed 1 m. p. S. giver Strømhastighed 1.5 Kvartmil i 24 Timer eller 0.032206 Meter pr. Secund [log 0.032206 = 8.50794].

Man har i den senere Tid gjort Indvendinger mod Rigtigheden af Scotts Reductionstabel, der hovedsagelig gaa i den Retning, at den til en vis Vind-Styrke svarende Hastighed skulde være mindre end den, Scotts Tabel angiver. Saalænge Discussionen om denne Sag ikke har faaet nogen bestemt Afslutning, har jeg fundet at burde holde mig til Scotts Tabel, saameget mere, som de samme Data, der ere benyttede til at udlede Strømhastighedsfactoren, tidligere[1] have ledet til en særdeles god Overensstemmelse mellem den efter Scotts Tabel beregnede Vindhastighed og den af Barometerhøjderne paa dynamisk Vej beregnede. Den af Gradienten beregnede Vindhastighed var nemlig 9.15 m. p. S., medens den af den observerede Vindstyrke efter Scotts Tabel udledede var 9.38 m. p. S. Forskjellen, 0.23 m., peger i samme Retning som ovenfor bemerket og antyder en Formindskelse, dog kun af 2.5 Procent. En Formindskelse af de respective Vindhastigheder vilde forøvrigt give Vinden en forholdvis større Evne til at fremkalde Strøm.

Den Maade, hvorpaa Vinden virker paa den med Is dækkede Del af Havet, er en anden end den, hvorpaa den virker paa det aabne Hav. For det første svækkes selve Vindens Styrke, som vi ovenfor have seet, ved at den blæser over Isen, og dernæst har Vinden at sætte i Bevægelse directe selve Isen og gjennem dens Bevægelse middelbart Vandet. Da Havisen frembyder en yderst ujevn saavel Overflade som Underflade og kan paa sine Steder stikke temmelig dybt, maa man vente, at Vindens Virkning til at sætte et isfyldt Hav i Bevægelse resulterer i en langsommere Fart, end naar Havet er isfrit. For at faa et Maal for denne Virkning, med andre Ord, for at finde Strømfactoren for det isfyldte Hav har jeg benyttet Sir Leopold M'Clintock's Observationer fra "Fox"'s Drift i Baffins-Bugt og Davis-Strædet Vinteren 1857—58. Efter disse har man følgende Tabel, i hvilken Vindstyrken (den observerede, altsaa af Isen paavirkede) er angivet efter Beaufort Skala, Driftens Retning efter den Compasstreg, henimod hvilken den fandt Sted, og Driftens Hastighed i Kvartmil

[1] Ueber die Bewegung der horizontalen Luftströme in der Nähe des Æquators. Von C. M. Guldberg und H. Mohn. Zeitschrift der østerreichischen Gesellschaft für Meteorologie 1877, S. 182. Tallet 9.15 er beregnet efter de til Normaltyngden reducerede Barometerhøjder.

corresponds to a velocity of 18 miles an hour, and a velocity of 4 to 23 miles. From these figures was computed, that a wind-force of 3.9 corresponds to 22.5 miles an hour. As 1 mile an hour corresponds to 0.447 metre per second, we get —

Force of wind 3.9 = 10.0 metres pr. second;

hence, to a wind-velocity of 10.0 m. per second corresponds a current-velocity of 15 nautical miles in 24 hours, or, putting the current-velocity proportional to the wind-velocity,

a wind-velocity of 1 m. per second gives a current-velocity of 1.5 nautical miles in 24 hours, or 0.032206 metre per second [log 0.032206 = 8.50794].

Of late objections have been made to Scott's Table of Reduction, which conclude in assuming the velocity corresponding to a given force of wind as less than given in Scott's Table. So long as the discussion on this subject has not attained a definite conclusion, I have seen fit to abide by Scott's Table, more especially since the same data that have been used for educing the factor for current velocity, on a former occasion led to excellent agreement between the velocity of wind computed according to Scott's Table and that computed dynamically.[1] The wind-velocity computed from the gradient was namely found to be 9.15 m. per sec., whereas that deduced from the observed force of the wind according to Scott's Table was 9.38 m. per sec. The difference, 0.23 m., points in the same direction, as remarked above, and indicates a decrease, but of only 2.5 per cent. Besides, a diminution of the respective wind-velocities would give the wind a proportionally greater power to produce currents.

The way in which the wind acts on the ice-covered part of the sea, is another compared to its action on the open water. To begin with, the force of the wind itself is materially weakened, as shown above, by blowing over ice; and in the next place, the wind has to impart motion directly to the ice, and through that motion indirectly to the water beneath it. Sea-ice presenting an exceedingly rough surface, both the upper and the under, and reaching in places a considerable depth, we cannot but expect that the power of the wind to set in motion an ice-encumbered sea should result in a slower rate than with a sea free of ice. To obtain a standard for this influence, or, in other words, to find the current-factor for an ice-encumbered sea, I made use of Sir Leopold M'Clintock's observations from the drift of the "Fox" in Baffin's Bay and Davis Strait during the winter 1857—58. From these we have the following Table, in which the force of the wind (viz., the observed, or that influenced by the ice) is given according to Beaufort Scale, the direction of the drift by the point of the com-

[1] Ueber die Bewegung der horizontalen Luftströme in der Nähe des Æquators. Von C. M. Guldberg und H. Mohn. Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, p. 182. The figures 9.15 have been computed from the heights of the barometer reduced to normal gravity.

i en Maaned[1]. De Maaneder, October og November, i hvilke Driften gik i Retninger, der vare betydelig afvigende fra Vindens Middelretning, ere ikke medtagne. I de øvrige Maaneder gaar, som man ser, Driften meget nær i samme Retning som den herskende Vind.

pass towards which it moves, and the rate of the drift in nautical miles for one month.[1] The months October and November, during which the drift took directions deviating very considerably from the mean direction of the wind, have not been included. In the other months, the drift had, as will be seen, very nearly the same direction as the prevailing wind.

Maaned (*Month*)	Dage (*Days*)	Vind Retning (*Wind Direction*)	Vind Styrke (*Force*)	Drift Retning (*Drift Direction*)	Drift Hast. (*Rate*)	Vind Hast. (*Wind Velocity*)	Drift i 24 h.	f
September	30	N. 8° E.	2.8	S. 40° W.	37′	7.8	1.′23	0. 16
December	31	N. 61° W.	3.2	S. 47° E.	68	8.6	2. 19	0. 26
Januar	31	N. 44° W.	4.6	S. 45° E.	113	11.7	3. 65	0. 31
Februar	28	N. 26° W.	5.1	S. 5° E.	166	12.6	5. 93	0. 47
Marts	31	N. 19° W.	4.0	S. 16° E.	94	10.2	3. 03	0. 30
April	23	N. 11° W.	5.3	S.	168	13.2	7. 30	0. 56

I den anden Del af Tabellen er Vindhastigheden den efter Scotts Tabel til Meter p. S. omsatte Styrke, Driften beregnet i Kvartmil i 24 Timer og f Forholdet mellem Isens Hastighed i Kvartmil i 24 Timer og en Vindhastighed af 1 Meter per Secund. Tages Middel af disse Tal (Summen af Drift: Summen af Vindhastighed) faar man som Resultat, at en (observeret) Vindhastighed af 1 m. p. S. skulde frembringe en Hastighed af Isen (og dermed af Vandets Overflade) af 0.36 Kvartmil i 24 Timer (0.008 m. p. S.) For det aabne Hav fandtes ovenfor Factoren 1.5 Kvartmil. Den samme Vindhastighed driver altsaa den aabne Havflade 4.2 Gange hurtigere frem end den isbelagte Overflade.

Isen i Baffinsbugt var hindret i sin Bevægelse derved, at den paa begge Sider stødte til Land. I Grønlandshavet og i Østhavet er dette Tilfældet kun paa den Side, der stoder til Grønlands Østkyst eller til Østspidsbergen og Franz-Joseph-Land, medens Havoverfladen ved Isgrændsen kan antage den hele, det aabne Hav tilkommende, Hastighed. Jeg regner derfor, at Strømfactoren f voxer fra Kysten (0.008) udover mod Isgrændsen saaledes, at Tilvæxten er jevn, og at den ved Isgrændsen selv gaar op til den, som gjælder for det aabne Hav (0.0322).

I Østhavet er paa samme Maade regnet, mellem Østspidsbergen og Novaja Semlja, med Factorer fra 0.008 (77°.5 N. 40° E.) til 0.0322 ved Isgrændsen.

Ved Hjelp af de anførte Factorer beregnedes de til forskellige Vindhastigheder svarende Strømhastigheder. Disse afsattes paa et Kart (Pl. XXXII). Dette viser saaledes de normale Vindes directe, locale Virkning paa Havoverfladen. Men disse directe Indvirkninger kan Havfladens Bevægelse ikke følge paa alle Steder. Langt ude paa Havet, fjernt fra Kysterne, er saadant tildels muligt, men nærmere Kysterne maa Havets Bevægelse rette sig efter

In the second part of the Table, the velocity of the wind is the force converted by Scott's Table into metres per second; the rate of the drift that computed in nautical miles per 24 hours; and f the ratio of the motion of the ice in nautical miles per 24 hours to a wind-velocity of 1 metre per second. Now, if we take the mean of these figures (sum of drift divided by sum of wind-velocity), the result will be that a wind-velocity of 1 metre per second (as observed) should produce a rate of motion in the ice — and thereby in the surface of the water — reaching 0.36 nautical mile in 24 hours (0.008 m. per sec.). For the open sea, I found, as stated above, the factor 1.5 nautical mile. Hence, the same velocity of wind impels the open surface of the sea at a rate 4.2 times greater than it does an ice-encumbered surface.

The ice in Baffin's Bay is obstructed in its motion by coming on both sides in contact with land. In the Greenland Sea and the Barents Sea this occurs on one side only, viz., that adjoining the east coast of Greenland or East Spitzbergen and Franz-Josephs-Land, whereas at the ice-limit, the sea-surface can assume the full rate of the open sea. Hence I take the current-factor, f, as increasing from the coast (0.008) towards the ice-limit, in such manner that the increase is uniform, and reaches at the ice-limit that found for the open sea (0.0322).

For the Barents Sea, between East Spitzbergen and Novaja Semlja, I have in like manner computed with factors from 0.008 (lat. 77°.5 N, long. 40° E) to 0.0322 at the ice-limit.

By means of the given factors, I calculated the velocities of currents corresponding to the different velocities of wind. The said velocities were marked off on a map, Pl. XXXII. This shows accordingly the direct, local effect of normal winds on the surface of the sea. But such direct impulse the motion of the sea-surface cannot follow in all places. Far out, at a great distance from the coasts, this may indeed to some extent be possible, but nearer the

[1] Weyprecht. Die Metamorphosen des Polareises. S. 225.

[1] Weyprecht. Die Metamorphosen des Polareises, p. 225.

disses Form og Retning. Kun hvor Kysten løber i samme Retning, som Vinden, vil Havets Bevægelse kunne følge dennes Retning. Hvor derimod Vindens Retning danner en Vinkel med Kystens, maa Strømmen følge denne og faar en Bevægelsesretning, der afviger fra Vindens. Den Hastighed, hvormed Strømmen vil løbe, bliver ligesaameget afhængig af de Vinde, der blæse i dens Ryg og i dens Front, som af dem, der blæse paa selve Stedet, og desuden af Kystens og Havbundens Form og Stilling til de virkende Vinde. At finde det Strømsystem, der svarer til Vindsystemet i Kartet Pl. XXXI, ved nogen exact Beregning, ligger vel for Tiden udenfor Mulighedens Grændser. Jeg har derfor forsøgt at construere det op efter et Skjøn, efter de givne Data og de Principer, som jeg i det Følgende skal gjøre Rede for.

Af Vindkartet, Pl. XXXI, ser man, at Vindene i Atlanterhavet drive Vandet dels opimod Islands Sydkyst og videre langs Islands Vestkyst samt, mellem Island og Skotland, ind i det norske Hav.

Mellem den barometriske Indsænkning, der strækker sig fra Strøget østenfor Island forbi Nordkap ind i Østhavet, og Norges Vestkyst drive Vindene Vandet videre nordover og ind i den sydlige Del af Østhavet. Her følger det Finmarkens, Ruslands og Novaja Semljas Kyster, drevet fremad af de herskende Vinde. I den nordlige Del af Østhavet ere de herskende Vinde østlige. De føre efterhaanden en Del af det atlantiske Vand henimod Beeren-Eiland og Spidsbergen. I Grønlandshavet herske, paa Nordvestsiden af Lufttrykkets Minimumzone, nordostlige og nordlige Vinde, der føre Vandet videre mod Vest og — under Grønland fra det indre Ishav — mod Syd langs Grønlands Østkyst og forbi Jan Mayen til Danmarkstrædet og Islands Østkyst. I vort Nordhav maa saaledes det cycloniske Vindsystem fremkalde et tilsvarende Strømsystem.

Det barometriske Minimums langstrakte Zone ligger, i dens nordlige Del, meget excentrisk i Havet. En tilsvarende excentrisk Beliggenhed af Strømsystemets Midtparti, nær det nordlige Norge, kan ikke antages at finde Sted. Udstrækningen og Styrken af de sydvestlige Vinde udenfor Norges Vestkyst overvejer de nordostlige Vindes mellem Spidsbergens Sydkap og Beeren Eiland. Vestenfor Nordkap maa derfor den nordgaaende Strøm skride hen over den barometriske Indsænknings Omraade. En saa stor Hastighed af Strømmen ved Nordkap, som det trange Rum mellem Lufttrykkets Minimum i Vest for Nordkap (755.3 mm, Pl. XXXI) og Norges Kyst vilde medføre, bekræftes ikke af Iagttagelserne. Jeg lader derfor Strømsystemets Axe gaa langs Linien A B (Pl. XXXIII). Paa den sydøstre Side af denne Linie løber Strømmen nordover, paa den nordvestre Side sydover.

coasts the motion of the sea must inevitably be influenced by their form and direction. Only where the coast has the same direction as the wind, will the motion of the sea be able to follow the direction of the latter. On the other hand, where the wind forms an angle with the coast, the current must needs follow the latter, and will take a motion deviating in direction from that of the wind. The rate acquired by the current will be no less dependant on the winds that blow behind and in front than on those at the place itself, as also on the form of the coast and the sea-bottom and their relative direction to the operating winds. Now, to find by exact computation the current-system corresponding to the wind-system set forth in the map, Pl. XXXI, lies no doubt at present beyond the limits of possibility. Hence I have sought to construct it by estimate, from the given data and the principles I shall explain in the sequel.

From the Wind-Chart, Pl. XXXI, we see that the winds in the Atlantic Ocean force the water partly up against the south coast of Iceland, and thence along the western coast of that island, as also, between Iceland and Scotland, into the Norwegian Sea.

Between the barometrical depression extending from the tract east of Iceland, past the North Cape into the Barents Sea, and the West Coast of Norway, the winds force the water farther north, and into the southern part of the Barents Sea. Here it follows the coasts of Finmark, Russia, and Novaja Semlja, impelled onward by the prevailing winds. In the northern part of the Barents Sea the prevailing winds are easterly. They carry by degrees part of the Atlantic water towards Beeren Eiland and Spitzbergen. In the Greenland Sea, on the north-western side of the minimum-zone of atmospheric pressure, north-easterly and northerly winds are found to prevail, which carry the water farther west and — off Greenland from the inner Polar Sea — towards the south, along the east coast of Greenland and past Jan-Mayen to Denmark Strait and the east coast of Iceland. Hence, in the North Ocean, the cyclonic wind-system must give rise to a corresponding current-system.

The barometrical minimum's elongated zone lies throughout its northern part very excentric in the sea. A corresponding excentric position of the medial part of the current-system in proximity to northern Norway cannot be assumed. The extension and force of the south-westerly winds blowing off the West Coast of Norway preponderate over that of the north-easterly winds blowing between South Cape, Spitzbergen, and Beeren Eiland. Hence, west of the North Cape, the current setting northwards must flow over the limits of the barometrical depression. A velocity of current at the North Cape as high as that which the narrow space between the minimum of atmospheric pressure west of the North Cape (755.3 mm., Pl. XXXI) and the coast of Norway would occasion, is not shown by the observations. Accordingly, I have drawn the axis of the current-system congruent with the line A B (Pl. XXXIII). On the south-eastern side of this line, the current sets northwards; on the north-western, southwards.

Paa et Kart, hvor denne Axe A B afsattes, optegnedes Linier, der betegne de af Vinden fremkaldte Overfladestrømmes sandsynlige Retning. Denne bestemmes i Axens Nærhed af dennes Retning. Ved Kysterne følger den Kystens Retning. Mellem Axen og Kysterne følge Strøm-Linierne de herskende Vindes Retning, forsaavidt som disse tillade det. Hvor de herskende Vinde ikke blæse langs med Kysterne, er Strømliniernes Retning trukket saaledes, at de give et continuerligt Strømsystem, der fører Havoverfladens Bevægelse, med snart udvidet, snart indsnevret Tversnit, rundt om Axen og langs med Kysterne. Et saadant System af sammenhængende Strømlinier er fremstillet i Pl. XXXIII, her yderligere støttet paa Beregninger, der skulle meddeles i det følgende Capitel, hvor der er Tale om Hastighederne. I nærværende Capitel beskjæftige vi os væsentlig kun med Vindstrømmens Retning.

I Nordsøen ere de herskende Vinde vestsydvestlige og vestlige og have en Hastighed af 3 til 4 Meter pr. Secund. Deres umiddelbare Virkning paa Vandet er at trykke dette op mod Jyllands Vestkyst. Her maa saaledes Vandet løbe nordover. Ved Skotlands og Englands Østkyst, hvorfra Vandet drives bort mod Øst, vilde der danne sig en Fordybning under Niveaufladen. Denne Fordybning vil det omgivende Vand søge at fylde. Dette kan ikke ske østenfra, thi Vandet føres af Vinden østover. Det kan ikke ske søndenfra, thi de herskende Vinde føre Vandet fra Strædet ved Dover østover. Det kan ikke ske vestenfra, thi her er Land. Fordybningen maa saaledes fyldes nordenfra. Gjennem Pentland Firth og forbi Orkenøerne maa Vandet fra Atlanterhavet bøje til højre og løbe sydover i den vestlige Del af Nordsøen, østover i den sydlige Del og nordover i den østlige Del. I Midten af den nordlige Del af Nordsøen bliver der en Slags Strøm-Axe, hvor Bevægelsen skifter fra sydgaaende til nordgaaende.

I Skagerak drive Vindene Vandet ind langs Jyllands Kyst. I den nordligste Del af Kattegat møder det Østersøens Vand, der paa Grund af sit højere Niveau vil rende ud i Nordsøen. Det indstrømmende Vand bøjer derfor inderst i Skagerak om og strømmer ud langs Norges Sydkyst. Her er, som Pl. XXXI viser, Lufttryksgradienten meget svag, Vindene i Aarets Løb omtrent ligesaa hyppig nordostlige som sydvestlige, medens de ved Skagen ere overvejende sydvestlige.

Den Bøjning mod Syd, som Strømlinierne faa i Nordsøen, giver sin tilsvarende Virkning tilkjende paa alle Strømlinier mellem Punktet A og Nordsøen: de bøjes ogsaa mod Syd, i Retning af Nordsøens Midte.

Udenfor Norges Vestkyst gaa Strømlinierne nogenlunde langs med Kysten. De knibe sig sammen mod Nord,

On a chart with the said axis A B set off, were drawn lines indicating the probable direction of the surface-current produced by the wind. This direction is determined in the proximity of the axis by the direction of the latter. Off the coasts, it follows the direction of the coast-line. Between the axis and the coasts, the stream-lines take the direction of the prevailing winds, provided the latter admit of their doing so. Where the prevailing winds do not blow along the coasts, the direction given to the stream-lines is such as to form a continuous current-system bearing onward the motion of the sea-surface, now with expanded, now narrowed sections, round about the axis and along the coastal lines. Such a system of continuous stream-lines is represented in Pl. XXXIII, deriving there additional support from computations to be set forth in the next chapter, which treats of velocities. In the present chapter our attention will be occupied chiefly with the direction of the wind-current.

Throughout the North Sea the prevailing winds are west-south-westerly and westerly, with a velocity of 3 to 4 metres per second. Their immediate influence on the water is to bank it up against the west coast of Jutland. Here, accordingly, the current must set northwards. Off the east coast of Scotland and England, whence the water is carried off towards the east, a depression would form beneath the surface of level. Now such a depression the surrounding water must seek to fill. But this cannot be done from the east, the water being carried off by the wind eastwards. Nor can it be effected from the south, the prevailing winds carrying the water from the Straits of Dover eastwards. Neither is it possible from the west; for in that direction we have land. Hence, the depression must be filled from the north. Through the Pentland Firth and past the Ørkney Islands, the water from the Atlantic must bend to the right and flow southwards in the western part of the North Sea, eastwards in the southern part, and northwards in the eastern part. In the middle of the northern part of the North Sea, occurs a kind of current-axis, where the motion changes from a southward to a northward.

Throughout the Skagerak, the winds force the water along the coast of Jutland. In the most northerly part of the Cattegat it meets the water of the Baltic, which, owing to its higher level, must flow into the North Sea. Accordingly the influx of water curves round farthest in the Skagerak and flows out along the south coast of Norway. Here, as shown in Pl. XXXI, the gradient of atmospheric pressure is very trifling; the winds that prevail in the course of the year blow almost as frequently from the north-east as from the south-west, whereas those at the Scaw are in greater part by far south-westerly.

The bend towards the south which the stream-lines exhibit in the North Sea, exerts a corresponding influence on all the stream-lines between the point A and the North Sea; they are, viz., bent southward towards the middle of the latter.

Off the West Coast of Norway, the stream-lines take very nearly the direction of the coast. They crowd

nærme sig Landet mest udenfor Finmarkens Kyst og bøje efterhaanden om mod Nord og Vest i den østlige Del af Østhavet, idet de følge de herskende Vindes Retning i det Store.

I den nordlige Del af Østhavet, mellem Østspidsbergen og Novaja Semlja, ere de herskende Vinde østlige. Her indtræder et lignende Tilfælde som i Nordsøen. Opstuvningen af Vandet ved Spidsbergens Østkyst driver Vandet her sydover; Vindene have en Component fra Nord. Under Novaja Semlja vil den tilsvarende Niveausynkning fyldes søndenfra directe af de herskende Vinde. Strømmen maa saaledes løbe nordover ved Novaja Semlja, og sydover ved Østspidsbergen. Midt imellem begge Lande er en langsom Overgang.

Ved Spidsbergens Vestkyst ere de herskende Vinde Landvinde. De stræbe at drive Vandet bort fra Kysten og at fremkalde en Synkning af Havniveauet. Denne fyldes søndenfra, hvor der staar en sterk Strømning fra Øst ud af Østhavet. Strømmen udenfor Spidsbergens Vestkyst løber nordover.

Efterhaanden faa de nordostlige Vinde i Grønlandshavet Overvægten. De drive Vandet nordenfor Strøm-Axen sydvestover fra Spidsbergens og Beeren-Eilands Bredder. Hele Grønlandshavet igjennem befordres Bevægelsen af de herskende Vinde. Ved Islands Nordostpynt, Langanes, kløves Strømmen i to. Den ene Del gaar ud gjennem Danmarkstrædet mod Vest, den anden mellem Øst-Island og Strøm-Axen mod Syd og videre mod Øst, idet den slutter sig til den directe Strøm fra Atlanterhavet.

together towards the north, approach the land nearest off the coast of Finmark, and curve in the eastern part of the Barents Sea gradually round towards the north and west, taking the general course of the prevailing winds.

In the northern part of the Barents Sea, between East Spitzbergen and Novaja Semlja, the prevailing winds are easterly. Here occurs a case similar to that in the North Sea. The banking-up off the east coast of Spitzbergen impels the water southward: the winds have a component from the north. Off Novaja Semlja, the corresponding depression is filled up direct from the south by the prevailing winds. Hence the current must set northwards at Novaja Semlja and southwards at East Spitzbergen. Midway between both islands there is a gradual transition.

Off the west coast of Spitzbergen, the prevailing winds are land-winds. They tend to force away the water from the coast, and to produce a depression of the sea-level. This is filled from the south, where a rapid current of water flows from the east out of the Barents Sea. The current off the west coast of Spitzbergen flows northward.

By degrees the north-easterly winds in the Greenland Sea acquire predominance. They force the water north of the current-axis south-westward, from the latitudes of Spitzbergen and Beeren Eiland. Throughout the entire tract of the Greenland Sea, the motion is kept up by the prevailing winds. At Langanes, the north-eastern extremity of Iceland, this current is split in two. One of its arms flows out through Denmark Strait towards the west, the other, between East Iceland and the current-axis, towards the south, passing on towards the east as it joins the current setting direct from the Atlantic.

4. Vind-Fladen.

Det Strøm-System, som ovenfor er beskrevet, har til Virkning en Afvigelse af Havets Overflade fra Niveaufladen. N i v e a u f l a d e n er den Flade, paa hvilken Tyngdens Retning, deri indbefattet Centrifugalkraftens, ved Jordens Rotation opstaaende Virkning, staar lodret. Det er den Form, Havets Overflade vilde antage, dersom det var i Ligevægt, altsaa uden Strømninger, og der paa alle Punkter af Overfladen hvilede det samme absolute Lufttryk. Denne Overflade er forskjellig fra den geometriske Sfæroide; den er den ved Land- og Vand-Massernes forskjellige Tiltrækning modificerede, fra Sfæroiden afvigende Flade, som man ogsaa kalder Geoiden. Ved Havets Strømninger antager dettes Overflade en fra Niveaufladen afvigende Form, som jeg beregner paa følgende Maade.

En Vandpartikkel, der bevæger sig i horizontal Retning med Hastigheden u, har, ligegyldigt i hvilket Azimuth Bevægelsen foregaar, paa Grund af Jordens Rotation og Kugleform, paa den nordlige Halvkugle en Bestræbelse

4. The Wind-Surface.

The current-system just described has the effect of producing a deviation in the surface of the sea from the surface of level. *The Surface of Level* is the surface to which the direction of gravity, including the effect of centrifugal force resulting from the earth's rotation, is perpendicular. It is the form the surface of the sea would assume if in equilibrium, or undisturbed by the influence of currents, and were every part of the surface to have the same absolute atmospheric pressure. This surface differs from the geometrical spheroid: it is the surface modified by the unequal attraction of the masses of land and water, deviating from the Spheroid, and likewise termed Geoid. The currents of the sea cause its surface to assume a form deviating from the surface of level — a form I compute in the following manner.

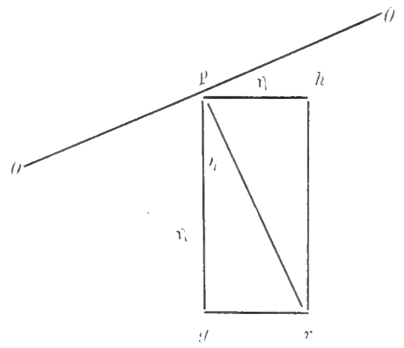
A particle of water that moves in a horizontal direction with the velocity u, will, no matter in what azimuth the motion takes place, owing to the rotation of the earth and its spherical form, on the northern hemisphere have

efter at afvige til Højre lodret paa Bevægelsens Retning. Maalet for denne Bestræbelse, udtrykt som accelererende Kraft, er

$$2\,\omega \sin \varphi\, u,$$

hvor ω er Jordens Omdrejnings Vinkelhastighed $2\,\pi : 86164 = 0.00007292$ (se ovenfor Side 114), φ den geografiske Bredde.

Idet Vandpartikkelen p samtidig paavirkes af Tyngden $p\,g$, som betegnes ved g, kommer Resultanten $p\,r$ af Tyngden og den ved Jordrotationen fremkaldte Afbøjningskraft $p\,h$ til at danne en Vinkel η med Tyngdens Retning. Havoverfladen $O\,O$ vil stille sig lodret paa denne Resultant, og altsaa danne en Vinkel η med Niveaufladen $p\,h$. Vandets Overflade løfter sig til højre, naar man ser frem i den Retning, i hvilken det bevæger sig. I denne skraa Flade er der Ligevægt, naar



a tendency to deviate towards the right, perpendicular to the direction of its motion. The measure of this tendency, expressed as accelerating force, is

$$2\,\omega \sin \varphi\, u,$$

in which ω represents the angular velocity of the earth's rotation, $2\,\pi : 86164 = 0.00007292$ (See p. 114), φ the latitude.

Now, the particle of water, p, being also acted upon by gravity, $p\,g$ (gravity I designate g), the resultant, $p\,r$, of gravity and the deviating force, $p\,h$, arising from the earth's rotation, will form an angle, η, with the direction of gravity. The surface of the sea, $O\,O$, will assume a position perpendicular to this resultant, and accordingly form an angle, η, with the surface of level. $p\,h$. The surface of the water rises upon the right when looking in the direction in which it moves. In this inclined surface there is equilibrium, when

$$p\,h \cos \eta = p\,g \sin \eta;\; 2\,\omega \sin \varphi.\, u.\, \cos \eta = g \sin \eta;\; \tang \eta = \frac{2\,\omega \sin \varphi}{g} \cdot u.$$

Tyngden, g, er forskjellig for forskjellige Bredder, og kan beregnes efter Formelen

$$g = g_{45}\,(1 - \beta \cos 2\,\varphi)$$

hvor $g_{45} = 9.806165$ og $\beta = 0.00259$ [1].

Vinkelen η bliver altid meget liden. For en Strømhastighed af 4 Kvartmil i 24 Timer eller 0.09 Meter per Secund bliver den kun $\frac{1}{4}$ Secund, og dens højeste Værdi i Nordhavet bliver $\frac{5}{4}$ Secund.

Ved ovenstaaende Beregning af Havoverfladens Skraahed have vi kun taget Hensyn til Jordrotationens Afbøjningskraft som den eneste i horizontal Retning virkende Kraft. Foruden denne virke ogsaa Centrifugalkraften, Frictionen og Trægheden [2].

Frictionen ved Vandets Bevægelse langt fra Kysterne og Bunden er kun den indre Friction mellem Vandtraade, der betinges af de til hverandre grændsende Traades forskjellige Hastighed. Denne Forskjel er yderst ringe, og vi kunne sætte Frictionens Virkning ud af Betragtning i Forhold til Afbøjningskraften.

Ogsaa til Trægheden tage vi intet Hensyn, idet over store Strækninger Strømmens Hastighed praktisk taget er uforandret. I Constructionen af Vind-Strøm-Systemet er taget Hensyn til Vandets jevne Bevægelse over længere Strækninger i Modsætning til Vindens.

Centrifugalkraftens Virkning bliver ogsaa meget ringe, og saagodtsom forsvindende i Forhold til Virkningen af

The force of gravity, g, is different for the different latitudes, and admits of being computed by the formula

$$g = g_{45}\,(1 - \beta \cos 2\,\varphi),$$

in which $g_{45} = 9.806165$ and $\beta = 0.00259$. [1]

The angle η will always be very small. For a current-velocity of 4 nautical miles in 24 hours, or 0.09 metres per second, it will amount to only $\frac{1}{4}$ second; and its highest value in the North Ocean does not exceed $\frac{5}{4}$ second.

In our computation set forth above of the inclination of the sea-surface, we had regard merely to the deviating force of the earth's rotation, as the only force acting in a horizontal direction. Besides, we have also centrifugal force, friction, and inertia exerting their influence. [2]

Friction attending the motion of the water far away from the coasts and the bed of the sea, is only the inner friction between threads of water caused by the different velocities of adjacent threads. Such difference is trifling in the extreme, and the effect of friction may be wholly set aside compared to that of the deviating force.

Of inertia likewise we take no account, since the velocity of the current, regarded practically, will continue unchanged throughout extensive tracts. When constructing the wind-current system, consideration was had to the uniform motion of the water over long tracts of ocean as contrasted with that of the wind.

The effect of centrifugal force is also exceedingly limited, nay well-nigh inappreciable compared to the effect of the

[1] O. J. Broch. Accélération de la pesanteur etc.

[2] Se Guldberg og Mohn, Études sur les mouvements de l'atmosphère, I, S. 19, og Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, S. 258.

[1] O. J. Broch. Accéleration de la pesanteur etc.

[2] See Guldberg and Mohn, Études sur les mouvements de l'atmosphère, I, p. 19; and Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1877, p. 258.

Jordrotationen. Et Exempel vil bedst oplyse dette. Vi vælge et Punkt i Østhavet, hvor baade Strømbanernes Krumning og Strømmens Hastighed er betydelig, nemlig ved Spidsbergens Sydkap. Centrifugalkraftens Størrelse er $\frac{u^2}{R}$, naar R er Krumningsradien for Banen. Kaldes den Heldningsvinkel, Centrifugalkraften vil frembringe, η', saa har man

$$\text{tang}\ \eta' = \frac{u^2}{g R}.$$

I vort Exempel har man $u = 0.13$ m. p. S., $g = 9.826$ og $R = 50000$ Meter, og deraf $\eta' = 0''.0071$. Paa samme Sted bliver $\eta = 0''.3785$ og altsaa $\eta' = \frac{\eta}{53}$.

Den Flade, Havets Overflade vilde indtage i Forhold til Niveaufladen, som Følge af de normale Vindes Virkning, kalder jeg Vind-Fladen. Dens Bestemmelse har jeg udført paa følgende Maade.

Vindfladen er i Pl. XXXIII fremstillet ved Linier, der gaa gjennem de Punkter, hvis verticale Afstand fra Niveaufladen gjennem Axen $A B$ er den samme. Disse Ligehøjde-Linier repræsentere ogsaa Linier for ligestor Trykhøjde, ganske som Isobarerne i Meteorologien. Da vi som virkende Kræfter antage alene Tyngden og Afbøjningen ved Jordrotationen, og se bort fra Friction, Træghed og Centrifugalkraft, maa, ligesom i Atmosfæren Luftens Bevægelse i dette Tilfælde gaar langs med Isobarerne, lodret paa Gradienten, med en Afbøjningsvinkel af 90°, Vandets Bevægelse følge Ligehøjde-Linierne. Da Vandets Bevægelse maa følge Kystliniens Retning, bliver den første Betingelsesligning, at en og samme Ligehøjde-Linie maa falde sammen med en og samme sammenhængende Kystlinie. Den Ligehøjde-Linie, som vi have ved Norges Vestkyst, maa vi ogsaa have paa den ene Side ved Finmarkens Kyst, ved Ruslands Nordkyst og ved Novaja Semlja, paa den anden Side ved Skagerak, Jyllands Vestkyst, Tysklands Nordsøkyst, Hollands og Belgiens Kyster, Frankrigs Kyst og de britiske Øers Kyster.

De Ligehøjde-Linier, som betegnes ved Islands, Spidsbergens og Grønlands Kyster, kunne tilhøre et lavere eller højere Niveau end den Linie, som betegnes ved Europas.

For at finde Niveauet ved Fastlandets Kyster opsøges et rent Strømprofil, der staar lodret paa Strømbanerne. Et saadant have vi fra A til Norges Kyst ved den 65. Breddegrad. Som man ser af Pl. XXXII, er i dette Strømhastigheden paa det nærmeste proportional med Afstanden fra A.

Sættes Strømhastigheden eller Tangenten til Heldningsvinkelen proportional med Afstanden fra A, bliver Overfladens Gjennemsnit med et verticalt Plan en Parabel, hvis Toppunkt er i A, og hvis Axe er vertical opad. Kaldes Afstanden fra A for x, Vindfladens verticale Ordinat i denne

rotation of the earth. This will best be shown by an example. Let us take a point in the Barents Sea where both the curvature of the course of the current and its velocity is considerable, viz., off South Cape Spitzbergen. The value of the centrifugal force is $\frac{u^2}{R}$, assuming R to be the radius of curvature of the course. Now, calling the angle of inclination which the centrifugal force will produce η', we have

$$\tan\ \eta' = \frac{u^2}{g R}.$$

In our example, $u = 0.13$ m. per sec., $g = 9.826$, and $R = 50000$ metres, wherefore $\eta' = 0''.0071$. At the same place $\eta = 0''.3785$, and hence $\eta' = \frac{\eta}{53}$.

The surface which the sea would assume relative to the surface of level consequent on the effect of the normal winds, I call the *Wind-Surface*. Its determination I have effected in the following manner.

The wind-surface is represented Pl. XXXIII, by lines passing through the points whose vertical distance from the surface of level through the axis $A B$ is the same. These lines of equal height also represent lines of an equal height of pressure, precisely as do the isobars in meteorology. Now, since gravity and the deviation arising from the rotation of the earth are the only forces to which we pay regard, putting aside friction, inertia, and centrifugal force, the motion of the water must — as in the atmosphere the motion of the air under a like supposition is along the isobars, perpendicular to the gradient, with a deviation of 90° — obviously follow the lines of equal height. As the motion of the water cannot but take the direction of the coastal line, the first equation of condition will be, that one and the same line of equal height must coincide with one and the same continuous coast-line. The line of equal height passing along the West Coast of Norway, we shall also have on the one side along the coast of Finmark, the north coast of Russia, and the coast of Novaja Semlja, on the other side along the Skagerak, the west coast of Jutland, the North-Sea coast of Germany, the coasts of Holland and Belgium, the coast of France, and the coasts of the British Islands.

The lines of equal height indicated by the coasts of Iceland, Spitzbergen, and Greenland, may lie at a lower or a higher level than does the line indicated by those of Europe.

In order to find the level at the coasts of the continent, a clear cross-section, cutting the stream-lines at right angles, must be sought out. Such a section we have from A to the coast of Norway, on the 65th parallel of latitude. As will be seen from Pl. XXXII, the current-velocity in this section is very nearly proportional to the distance from A.

Putting the current-velocity, or the tangent to the angle of inclination proportional to the distance from A, the section of the surface by a vertical plane will be a parabola having its vertex in A and its axis pointing vertically upwards. Now, calling x the distance from A; the

Afstand h og den tilsvarende Stromhastighed u, Heldningsvinkelen η, saa har man

$$\operatorname{tang} \eta = \frac{2\ \omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}\ u$$

$$h = \tfrac{1}{2}\ x \operatorname{tang} \eta = \frac{\omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}\ x.\ u. = k.\ x.\ u.$$

Regnes x i Kilometer, bliver Factoren

$$k = 1000\ \frac{\omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}$$

Den følgende Tabel giver Værdien af k for hver Breddegrad fra 55° til 80° og dens Logarithme.

vertical ordinate of the wind-surface for that distance h; the corresponding current-velocity u; and the angle of inclination η, we get

$$\tan \eta = \frac{2\ \omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}\ u$$

$$h = \tfrac{1}{2}\ x \tan \eta = \frac{\omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}\ x.\ u. = k.\ x.\ u.$$

Computing x in kilometres, the factor

$$k = 1000\ \frac{\omega \sin \varphi}{g_{45}\ (1-\beta \cos 2\ \varphi)}.$$

The following Table gives the value of k for every parallel of latitude from 55° to 80°, together with its logarithm.

φ	Log. k	Δ	k	Δ	φ	Log. k	Δ	k	Δ
55°	7.78433	517	0.006086	73	68°	7.83771	296	0.006882	47
56	78950	498	6159	71	69	84067	280	6929	45
57	79448	480	6230	69	70	84347	266	6974	43
58	79928	461	6299	67	71	84613	252	7017	40
59	80389	443	6366	66	72	84865	237	7057	39
60	80832	425	6432	63	73	85102	222	7096	37
61	81257	408	6495	61	74	85324	208	7133	34
62	81665	392	6556	59	75	85532	194	7167	32
63	82057	375	6615	58	76	85726	180	7199	30
64	82432	359	6673	55	77	85906	166	7229	27
65	82791	342	6728	54	78	86072	153	7256	26
66	83133	327	6782	51	79	86225	139	7282	23
67	83460	311	6833	49	80	86364		7305	
68	83771		6882						

Afstanden fra Punktet A til Norges Kyst ved den 65. Breddegrad er 640 Kilometer. Den midlere Bredde er 66°.2. Sættes, overensstemmende med Kartet, Pl. XXXII, Hastigheden ved Kysten lig 0.184 Meter per Secund, har man

$x = 640$ km, $\varphi = 66°.2$, $u = 0.184$ m og faar

$h = 0.80$ Meter.

Ved Continentet ligger saaledes Vindfladen 0.8 Meter over Niveaufladen gjennem dens dybeste Punkt.

Trækkes fra et Punkt i Axen AB en Linie, der skjærer Strømlinierne lodret, til et andet Punkt af Continentet, maa den Stigning, som Vindfladen, efter de antagne Strømhastigheder langs denne Linie, faar ved Kysten, ogsaa blive 0.8 Meter. I Kartet Pl. XXXIII er trukket en saadan Normal-Linie forbi Færøerne til Skotlands Nordkyst (Cap Wrath). Her have vi

$x = 1100$ km, $u = 0.11$, $\varphi = 63°.5$; hvoraf $h = 0.80$ Meter.

En lignende Normal er ført, lidt længere øst, fra A med en dobbelt Krumning vestenom Shetland til Skotlands Nordostpynt (Duncansby Head). Afstanden og Hastigheden blive de samme som i foregaaende Tilfælde, følgelig ogsaa Højden.

Fra A er ført en Normal til Norges Vestkyst ved Bergen. Vi have her $x = 1025$ km, $u = 0.118$ (lidt nordenfor 60° Bredde), $\varphi = 63°.0$, og faa $h = 0.80$ Meter.

The distance from the point A to the coast of Norway, on the 65th parallel of latitude, is 640 kilometres. The mean latitude is 66°.2. Now putting, in accordance with the map, Pl. XXXII, the velocity at the coast equal to 0.184 metre per second, we have

$x = 640$ km, $\varphi = 66°.2$, $u = 0.184$ m, and get

$h = 0.80$ metre.

Hence, at the continent the wind-surface lies 0.8 metre above the surface of level through its deepest point.

If, from a point in the axis AB, there be drawn a line, cutting the stream-lines perpendicularly, to some other point of the continent, the rise which the wind-surface according to the assumed current-velocities along that line will attain at the coast, must also be 0.8 metre. In the map, Pl. XXXIII, such a normal line has been drawn past the Færoe Islands to the north coast of Scotland (Cape Wrath). Here we have

$x = 1100$ km., $u = 0.11$, $\varphi = 63°.5$ whence $h = 0.80$ metre.

A similar normal line has been drawn a little farther east, from A, with a double curvature west of the Shetland Isles to the north-eastern extremity of Scotland (Duncansby Head). The distance and velocity will be the same as in the previous case, consequently the height too.

From A a normal line has been drawn to the West Coast of Norway, at Bergen. We have here $x = 1025$ km., $u = 0.118$ (a little to the north of the 60th parallel of latitude), $\varphi = 63°.0$, and get $h = 0.80$ metre.

Til at beregne Afstanden fra A af de Punkter i Normalerne, hvor Højden over Niveaufladen er 0.1, 0.2, 0.3 Meter o. s. v. have vi, naar Højden ved Kysten er H, Afstanden fra A langs Normalen til Kysten X, Højden h i Afstanden x:

$$x = \frac{X}{\sqrt{H}} \cdot \sqrt{h}.$$

Efter denne Formel ere Overskjæringspunkterne mellem Normalerne og Ligehøjde-Linierne beregnede.

Mellem de ovenfor beskrevne Normaler ligger den, der fører til Midten af Nordsøen. Langs denne har jeg tænkt mig tre Stykker af Parabelbuer. I et Punkt midt i Nordsøen, der hvor Ligehøjdelinien for 0.7 Meter har sit sydligste Punkt, er Toppunktet for en Parabel med opad vendende Axe, hvis Ordinat ved Texel er 0.8 Meter. Her bliver saaledes Hastigheden Nul i Punktet midt i Nordsøen. Ved Texel bliver efter Formelen

$$u = \frac{h}{kx} \text{ eller } U = \frac{H}{kX}$$

med $h = 0.8 - 0.7 = 0.1$ m, $\varphi = 54^0.5$ og $x = 310$ km Hastigheden $u = 0.05$ m. p. S.

Fra Midtpunktet i Nordsøen til A deler jeg Afstanden i to Dele; hver af dem bliver 700 km. Igjennem den sydlige Del tænker jeg mig en Parabel med Axen nedad og Toppunktet i Nordsø-Midtpunktet. Gjennem den nordlige Del lægger jeg en med denne congruent Parabel med Toppunktet i A og Axen opad. Højdeforskjellen mellem Yderpunkterne er 0.7 m, følgelig i begge Parabler $H = 0.35$ m. og $X = 700$ km. Der, hvor de støde sammen, 700 km fra A, bliver Højden 0.35 m og Hastigheden $U = 0.076$ m. p. S. Efter disse Data beregnedes Ligehøjdeliniernes Skjæringspunkter med Normalen og afsattes i Kartet.

Fra Punktet B føres en Normal til Norges Kyst ved Vesteraalen. Vi have $X = 535$ km, $\varphi = 69^0.6$, $H = 0.8$ m, og finde $U = 0.215$ m. p. S.

Fra B er ført en Normal langs Havfladens Fordybning i Østhavet til Jugor-Strædet (Novaja Semlja). Langs denne er tænkt en Parabelbue, med Toppunkt i B og Axen opad. I Østhavet følger nemlig Strømmen de herskende Vinde. I Nordsøen var dette ikke Tilfældet. Vi have $X = 2100$ km, $\varphi = 72^0.9$, $H = 0.8$ m, og finde ved Jugorstrædet $U = 0.054$ m. p. S. Efter disse Data ere Ligehøjdeliniernes Skjæringspunkter med Normalen beregnede.

Fra denne samme Normal, der danner Østhavets Strøm-Axe, lagdes Parabelbuer tvers paa Strømlinierne til Norges og den murmanske Kyst. Afstanden a maaltes paa Kartet.

To compute the distance from A of the points in the normal lines at which the height above the surface of level is 0.1, 0.2, 0.3 metre, etc., we have, when the height at the coast is H, the distance from A along the normal line to the coast X, and the height h at the distance x: —

$$x = \frac{X}{\sqrt{H}} \cdot \sqrt{h}.$$

According to this formula, the points of intersection between the normal lines and the lines of equal height have been computed.

Between the fore-described normal lines lies that extending to the middle of the North Sea. Along this line I have laid three arcs of parabolic curves. At a point in the middle of the North Sea where the line of equal height for 0.7 metre reaches its most southern point, I put the vertex of a parabola with upward-pointing axis, the ordinate of which at the Texel is 0.8 metre. Here, therefore, the velocity will be zero at the point in the middle of the North Sea. At the Texel, according to the formula

$$u = \frac{h}{kx}, \text{ or } U = \frac{H}{kX},$$

with $h = 0.8 - 0.7 = 0.1$ m, $\varphi = 54^0.5$, and $x = 310$ km., the velocity $u = 0.05$ m. per sec.

From the point in the middle of the North Sea to A, I divide the distance into two parts, each measuring 700 kilometres. Throughout the southern part I assume a parabola to pass, with its axis pointing downwards and its vertex in the mid-point of the North Sea. Throughout the northern part I lay down a parabola congruent with the former, having its vertex in A and its axis pointing upwards. The difference in height between the outermost points is 0.7 metre; hence in both parabolas $H = 0.35$ metre and $X = 700$ kilometres. Where they meet, viz., 700 kilometres from A, the height will be 0.35 metre and the velocity $U = 0.076$ metre per second. According to these data, the points of section for the lines of equal height with the normal line have been computed and set down on the map.

From the point B a normal line has been drawn to the coast of Norway, at Vesteraalen. Here we have $X = 535$ kilometres, $\varphi = 69^0.6$, $H = 0.8$ metre, and get $U = 0.215$ metre per second.

From B a normal line is made to pass along the surface-depression in the Barents Sea as far as Jugor Strait, Novaja Semlja. Along this depression is assumed a parabolic curve, with its vertex in B and its axis pointing upwards. In the Barents Sea, the current takes the direction of the prevailing winds. In the North Sea, this was not found to be the case. We have $X = 2100$ kilometres, $\varphi = 72^0.9$, $H = 0.8$ metre, and get at Jugor Strait $U = 0.054$ metre per second. According to these data, the points of section for the lines of equal height with the normal line have been computed.

From the same normal line, which constitutes the current-axis of the Barents Sea, parabolic curves were laid straight across the stream-lines to the Norwegian and the

Vi have videre til Beregningen

Hojden i Stromaxen $h_o = \frac{H}{X^2} x^2 = \frac{0.8}{2100^2} x^2$

hvor x er Afstanden fra B.

Kaldes Abscissen til Parabelens Punkt i Stromaxen x_o, ved Kysten X_o, saa har man $X_o - x_o = a$ og

$$\text{da } \frac{X_o}{x_o} = \frac{\sqrt{H}}{\sqrt{h_o}}; \quad \frac{X_o - x_o}{x_o} = \frac{\sqrt{H} - \sqrt{h_o}}{\sqrt{h_o}}; \quad \frac{a}{x_o} = \sqrt{\frac{H}{h_o}} - 1$$

$$x_o = \frac{a}{\sqrt{\frac{H}{h_o}} - 1}; \quad X_o = x_o + a.$$

Parabelens Toppunkt ligger i Afstanden X_o fra Kysten, hvor Hojden $H = 0.8$ m. Afsættes dette Toppunkt paa Kartet, og regnes Abscisserne x' derfra, har man til Bestemmelse af Ligehojdeliniernes Skjæringspunkter med Tvernormalerne

$$x' = \frac{X_o}{\sqrt{H}} \cdot \sqrt{h}.$$

Et saadant Tversnit er ført mod Nordkap fra det Punkt i Stromaxen, hvor $h_o = 0.1$ m. Vi have her $a = 280$ km, $H = 0.8$ m, $h_o = 0.1$ m og finde $X_o = 433$ km og den dertil svarende Hastighed $U_o = 0.26$ m. p. S.

Et lignende Tversnit føres fra $h_o = 0.3$ m til den murmanske Kyst østenfor Fisker-Øen. Med $a = 325$ km, $H = 0.8$ m og $h_o = 0.3$ m faaes $X_o = 838$ km og $U_o = 0.137$ m. p. S.

Ligesaa henimod Novaja Semlja fra $h_o = 0.2$ m. Her er $a = 750$ km, $H = 0.8$ m, $X_o = 1500$ km og $U_o = 0.075$ m. p. S.

Fra det Punkt i Østhavets Strømaxe, hvor $h_o = 0.05$ m, føres en Normal til Spidsbergens Sydkap. I det første Punkt sætter jeg hastigheden $u_o = 0.04$ m. p. S. (Middel af 0.013, i Strømaxen, og 0.07, efter Pl. XXXII). I det sidste Punkt sætter jeg Hastigheden lig 0.13 m. p. S. Kartet, Pl. XXXII, angiver her en Hastighed af over 0.14 m. p. S. Men Nærheden af Land og den Omstændighed, at den nævnte Værdi er en Maximumshastighed, tillader ikke at sætte den virkelige Hastighed saa stor.

Afstanden a mellem Punkterne er 360 km. Af $h_o = 0.05$ m, $\varphi = 75^0$ og $u_o = 0.04$ faa vi $x_o = 174$ km, altsaa $X_o = 534$ km, og deraf, med $U_o = 0.13$, Hojden ved Sydkap $H = 0.498$ m.

Efter dette bliver Vindfladens Hojde ved Spidsbergens Kyster at sætte til 0.5 Meter over Niveaufladen gjennem B eller A.

Fra B føres en Normal langs Strøm-Axen vestenfor Spidsbergen. Efter Strømliniernes Løb falder Skjæringspunktet mellem denne Normal og Ligehojdelinien for 0.4

Murman coasts. The distance a was measured off on the map. We have further for computation: —

Height in the current-axis $h_o = \frac{H}{X^2} x^2 = \frac{0.8}{2100^2} x^2.$

in which x is the distance from B.

Now, calling the abscissa of the point of the parabola in the current-axis x_o, at the coast X_o, we get $X_o - x_o = a$; and

$$\text{as } \frac{X_o}{x_o} = \frac{\sqrt{H}}{\sqrt{h_o}}; \quad \frac{X_o - x_o}{x_o} = \frac{\sqrt{H} - \sqrt{h_o}}{\sqrt{h_o}}; \quad \frac{a}{x_o} = \sqrt{\frac{H}{h_o}} - 1$$

$$x_o = \frac{a}{\sqrt{\frac{H}{h_o}} - 1}; \quad X_o = x_o + a.$$

The vertex of the parabola lies at the distance X_o from the coast, where the height $H = 0.8$ metre. If this vertex be set off on the map and the abscissæ x' reckoned from thence, we shall get for determining the points of section between the lines of equal height and the transverse normal lines

$$x' = \frac{X_o}{\sqrt{H}} \cdot \sqrt{h}.$$

Such a section has been drawn in the direction of the North Cape from the point in the current-axis at which $h_o = 0.1$ metre. We have here $a = 280$ kilometres, $H = 0.8$ metre, $h_o = 0.1$ metre, and get $X_o = 433$ kilometres, with the corresponding velocity $U_o = 0.26$ metre per second.

A similar transverse section was drawn from the point where $h_o = 0.3$ m. to the Murman coast, east of the Rybatschi Peninsula. With $a = 325$ km., $H = 0.8$ m., and $h_o = 0.3$ m., we get $X_o = 838$ kilometres, and $U_o = 0.137$ metre per second.

In like manner towards Novaja Semlja from the point where $h_o = 0.2$ metre. Here a is $= 750$ kilometres, $H = 0.8$ metre, $X = 1500$ kilometres, and $U_o = 0.075$ metre per second.

From the point in the current-axis of the Barents Sea at which $h_o = 0.05$ metre, a normal line has been drawn to South Cape, Spitzbergen. At the former point, I put the velocity, $u_o = 0.04$ m. per sec. (mean of 0.013, in the current-axis, and 0.07, from Pl. XXXII). At the latter point, I take the velocity equal to 0.13 metre per second. The map, Pl. XXXII, gives here a velocity of more than 0.14 metre per second. But the close proximity of land and the circumstance that the said value is a maximum-velocity, will not allow of putting the true velocity so high.

The distance, a, between the points is 360 km. With $h_o = 0.05$ m., $\varphi = 75^0$, and $u_o = 0.04$, we get $x_o = 174$ km.; hence $X_o = 534$ km., and, with $U_o = 0.13$, the height at South Cape, $H = 0.498$ metre.

According to this result, the height of the wind-surface at the coasts of Spitzbergen must be put at 0.5 metre above the surface of level through B or A.

From B a normal line has been drawn along the current-axis west of Spitzbergen. Judging from the course of the current-lines, the point of section between this norma

Meter i Vest for Nordpynten af Prince Charles Foreland. Herfra til B er 1070 km. Derefter beregnes Skjæringspunkterne for 0.3, 0.2 og 0.1 Meters Højde. Udenfor Prince Charles Foreland bliver Hastigheden 0.052 Meter pr. Secund.

Mellem B og Grønland (69°.2 N. Br.) have vi et rent Strømprofil til Bestemmelsen af Vindfladens Højde ved Grønlands Kyst. Fra B af voxer Hastigheden, indtil den i en Afstand af 335 km naar en Maximumsværdi af 0.13 m. p. S. I dette Punkt bliver Højden, beregnet efter den paraboliske Formel, 0.3065 Meter.

I en Afstand fra dette Punkt henimod Grønland af 510 km (a) giver Pl. XXXII en Hastighed af 0.03 m. p. S. Lægges over dette Snit en Parabel, med Toppunkt inde i Grønland og Axen nedad, saa have vi, naar Afstanden fra dette Toppunkt til det Punkt, hvor Hastigheden er 0.03 (u), er x, og Afstanden til det Punkt, hvor Hastigheden er 0.13 (U), er X:

line and the line of equal height for 0.4 metre, lies west of the northern extremity of Prince Charles' Foreland. From here to B the distance is 1070 kilometres. With these figures, the points of section are computed for a height of 0.3, 0.2, and 0.1 metre. Off Prince Charles' Foreland, the velocity becomes 0.052 metre per second.

Between B and Greenland (lat. 69°.2 N), we have a clear cross-section for determining the height of the wind-surface at the coast of Greenland. From B the velocity increases, till, at a distance of 335 kilometres, it attains a maximum-value of 0.13 metre per second. At this point, the height, computed according to the parabolic formula, becomes 0.3065 metre.

At a distance of 510 kilometres (a) from this point towards Greenland, the Pl. XXXII gives a velocity of 0.03 metre per second. If, on this section, we lay a parabola with its vertex in the interior of Greenland and its axis pointing downwards, we shall have, assuming the distance from the said vertex to the point where the velocity is 0.03 (u) to be x, and the distance to the point where the velocity is 0.13 (U) to be X —

$$\frac{X}{x} = \frac{U}{u};\ \frac{X-x}{x} = \frac{U-u}{u};\ x = (X-x)\,\frac{u}{U-u} = 510\,\frac{0.03}{0.10} = 153 \text{ km.}$$

Altsaa $X = 510 + 153 = 663$ km.

Heraf faar man $H_o = k\,U\,X = 0.6132$ m ved Toppunktet.

Da Kysten ligger 110 km fra Toppunktet, bliver ved Kysten

$$H_o - H = H_o \left(\frac{110}{663}\right)^2 = 0.6132 \left(\frac{110}{663}\right)^2 = 0.0169 \text{ Meter.}$$

Altsaa $H = 0.6132 - 0.0169 = 0.5963$ m, og Højden ved Grønland over $B =$

$0.3065 + 0.5963 = 0.9028$ Meter.

Jeg sætter saaledes Vindfladens Højde ved Grønland til 0.9 Meter.

Mellem det her beskrevne Snit og Spidsberg-Axen er lagt en Normal til Grønlands Kyst paa 76°.5 N. Br. Paa denne er oprejst to Stykker congruente Parabelbuer, den ene med Toppunkt i B og Axen opad, den anden med Toppunktet inde i Grønland (paa 24° W. Længde) med Axen nedad. Imellem B og dette Punkt er en Afstand af 1300 km. Midt imellem begge bliver Højden over B $\frac{1}{2}$ (0.917) eller 0.458 Meter, Hastigheden 0.10 m. p. S. Ved Grønlands Kyst have vi Højden 0.9 Meter og Hastigheden 0.03 m. p. S.

Imellem Grønland og Islands Nordkyst er lagt et Normalsnit. Vi have her ved Grønlands Kyst Højden $H = 0.9$ m, Hastigheden $u = 0.04$ m. p. S. og i en Afstand a af 240 km derfra en Maximumshastighed U af 0.13 m. p. S. I den tilsvarende Parabel, hvis Toppunkt ligger inde i Grønland med Axen nedad, kalde vi Abscissen for det Punkt, som har Hastigheden u, for h, og Ordinaten for x, og for det Punkt, som har Hastigheden U, Abscissen H og Ordinaten X.

Hence $X = 510 + 153 = 663$ kilometres.

We thus get $H_o = k\,U\,X = 0.6132$ metre at the vertex.

Now, since the coast lies at a distance of 110 kilometres from the vertex, at the coast

$$H_o - H = H_o \left(\frac{110}{663}\right)^2 = 0.6132 \left(\frac{110}{663}\right)^2 = 0.0169 \text{ metre.}$$

Hence $H = 0.6132 - 0.0169 = 0.5963$ metre, and the height at Greenland above $B =$

$0.3065 + 0.5963 = 0.9028$ metre.

Accordingly, I take the height of the wind-surface on the coast of Greenland at 0.9 metre.

Between the above-described section and the Spitzbergen axis, a normal line has been drawn to Greenland, touching the coast in lat. 76°.5 N. Along this line have been constructed two congruent parabolic curves, the one with its vertex in B and its axis pointing upwards, the other with its vertex in the interior of Greenland (long. 24° W) and its axis pointing downwards. Between B and this point, the distance measures 1300 kilometres. Midway between both, the height above B becomes $\frac{1}{2}$ (0.917), or 0.458 metre, the velocity 0.10 metre per second. At the coast of Greenland, we have the height 0.9 metre, and the velocity 0.03 metre per second.

Between Greenland and the north coast of Iceland, a normal section has been laid down. We have here, at the coast of Greenland, the height $H = 0.9$ m., the velocity $u = 0.04$ m. per sec., and at the distance, a, of 240 kilometres from thence a maximum-velocity, U, of 0.13 m. per sec. In the corresponding parabola, the vertex of which lies in the interior of Greenland, with its axis pointing downwards, we call the abscissa h and the ordinate x for the point with the velocity u, and the abscissa H and the ordinate X for the point with the velocity U.

Vi have saaledes $X - x = a$, og

We have thus $X - x = a$, and

$$\frac{X}{x} = \frac{U}{u};\ \frac{X-x}{X} = \frac{U-u}{U};\ X = a.\ \frac{U}{U-u} = 240.\ \frac{0.13}{0.09} = 540 \text{ km.}$$

Heraf faaes (*This gives*) $H = k\,X\,U = 0.485$ m. $x = X - a = 540 - 240 = 300$ km.

$$h = H\left(\frac{x}{X}\right)^2 = 0.485\left(\frac{300}{540}\right)^2 = 0.149 \text{ m.}$$

Toppunktets Hoide $= 0.9 + 0.149 = 1.049$ m. Højden af Punktet $U =$
$1.049 - H = 1.049 - 0.485 = 0.564$ m.

Fra Punktet med Hastigheden $U = 0.13$ til Islands Kyst er Afstanden a lig 170 km, og ved Kysten Hastigheden u lig 0.10 m. p. S. Den tilsvarende Parabel har sit Toppunkt søndenfor Island, og Axen vender opad. Med de samme Betegnelser som ovenfor findes

The height of the vertex $= 0.9 + 0.149 = 1.049$ m. The height of the point $U =$
$1.049 - H = 1.049 - 0.485 = 0.564$ m.

From the point with the velocity $U = 0.13$ to the coast of Iceland, the distance a is equal to 170 kilometres; and at the coast the velocity u equals 0.10 metre per sec. The corresponding parabola has its vertex south of Iceland, and its axis pointing upwards. With the same denominations as above, we get

$$\frac{X}{x} = \frac{U}{u};\ \frac{X-x}{x} = \frac{U-u}{u};\ x = (X-x)\ \frac{u}{U-u} = a\ \frac{u}{U-u} = 170.\ \frac{0.10}{0.03} = 567 \text{ km.}$$

Altsaa (*Hence*) $X = 567 + 170 = 737$ km. $H = k\,U\,X = 0.655$ m.

$$h = H\left(\frac{x}{X}\right)^2 = 0.655\left(\frac{567}{737}\right)^2 = 0.387 \text{ m.}$$

Højden ved Islands Kyst $=$
$0.564 - (0.655 - 0.387) = 0.564 - 0.268 = 0.296$ m.

Føres et Normalsnit fra Punktet A til Islands Østkyst, kan man regne med $X = 685$ km, $U = 0.065$ (Middel af Hastighederne nordenfor) og faar deraf $H = 0.3007$ Meter. Dette stemmer med Islandskystens Højde over Niveaufladen, beregnet fra Grønland af. Middel af begge er $\frac{1}{2}(0.296 + 0.301) = 0.299$ Meter. Islandskystens Højde kan saaledes sættes til 0.3 Meter.

Med et Punkt i Atlanterhavet som Centrum søndenfor Island ere Ligehojdelinierne beregnede efter Afstanden til Island og til Irland med de respektive Værdier af $H = 0.3$ og 0.8 Meter.

Den saaledes fundne Form af Vindfladen er fremstillet i Kartet Pl. XXXIII. Dens dybeste Parti AB ligger 0.8 Meter under Europas Kyst, 0.9 Meter under Grønlands Kyst, 0.5 Meter under Spidsbergens Kyst og 0.3 Meter under Islands Kyst.

The height at the coast of Iceland $=$
$0.564 - (0.655 - 0.387) = 0.564 - 0.268 = 0.296$ metre.

If a normal section be drawn from the point A to the east coast of Iceland, we can calculate with $X = 685$ kms, $U = 0.065$ (mean of velocities farther north); and obtain $H = 0.3007$ metre. This result agrees with that for the height of the coast of Iceland above the surface of level computed from Greenland. The mean of both is $\frac{1}{2}(0.296 + 0.301) = 0.299$ metre. Hence, the height of the coast of Iceland may be taken at 0.3 metre.

With a point in the Atlantic south of Iceland as centre, the lines of equal height have been computed according to the distance from Iceland and from Ireland, and with the respective values of $H = 0.3$ and 0.8 metre.

The form of the wind-surface thus found has been represented in the map, Pl. XXXIII. Its deepest part, $A\,B$, lies 0.8 metre beneath the coast of Europe, 0.9 metre beneath the coast of Greenland, 0.5 metre beneath the coast of Spitzbergen, and 0.3 metre beneath the coast of Iceland.

5. Havvandets specifiske Vægt.

Hvad Bestemmelsen af denne for Havets Bevægelse vigtige Factor angaar, henvises til H. Tornøes Afhandling i denne Generalberetning[1].

De i Tornøes Tabeller[2] givne Værdier af Havvandets

5. Specific Gravity of the Sea-Water.

As regards determining this factor, so important for the motion of the sea, the author refers to H. Tornøe's Memoir, published in this General Report.[1]

The values given in Tornøe's Tables[2] for the specific

[1] Den norske Nordhavs-Expedition. Chemi. H. Tornøe.

[2] L. c. S. 59—64.

[1] The Norwegian North-Atlantic Expedition. Chemistry. H. Tornøe.

[2] Ibid., p. 59—64.

specifiske Vægt ved $\frac{17^{\circ}.5}{17^{\circ}.5}$ har jeg benyttet paa samme Maade som Havtemperaturerne til Construction af Karter over dens Fordeling i Overfladen og ved Bunden samt af verticale Tversnit. Disse tilsammen fremstille den specifiske Vægts eller den dermed proportionale Saltholdigheds Fordeling i horizontal og vertical Retning i Nordhavet. Under dette Arbejde viste der sig enkelte Uregelmæssigheder, som maatte elimineres, og som jeg her skal gjøre Rede for.

Udenfor Norges Kyst fra Stad til Lofoten give de directe Observationer, som Tornøes Kart viser, i Overfladen meget bugtede Linier for lige Saltholdighed. Disse har jeg troet at burde udjevne, og jeg har trukket mine Linier (Pl. XXXIV) langs Kysten uden videre Krumninger. Bestemmelserne af den specifiske Vægt i Overfladen ere gjorte med Vand fra Overfladen selv. I denne kunne forskjellige Aarsager, som Nedbør, sterk Fordunstning, let fremkalde locale og temporære Afvigelser fra den normale Saltholdighed[1].

I 1877 og 1878 er Saltholdigheden bestemt saavel ved Aræometer som ved Chlormængden. Som man af Tornøes Tabeller ser, stemme Resultaterne af disse Fremgangsmaader i Almindelighed meget vel overens. I disse Tilfælder har jeg taget Middeltallet af begge, idet jeg, efter Tornøes Methode, først omgjorde Tallene i hans Rubrik "Saltmængde efter Chlormængde" til spec. Vægt v. $\frac{17^{\circ}.5}{17^{\circ}.5}$. Paa nogle faa Steder er der større Afvigelser mellem Aræometer- og Chlorbestemmelserne. Ved Hjelp af Karterne og Tversnittene kunde jeg strax se, hvilken af disse Bestemmelser der sluttede sig bedst til det af de øvrige Observationer givne System, og denne blev da valgt, med Udelukkelse af den anden, enten denne var Chlorbestemmelse eller Aræometerbestemmelse.

Da det var af Interesse at udvide Systemet til forskjellige Dele af Nordhavet, som vor Expedition ikke kom til at besøge, har jeg søgt at udfylde det ved Hjelp af Iagttagelser fra andre Expeditioner. I første Række staar her den anden tyske Nordfart[2]. Da Aræometerobservationer fra forskjellige Expeditioner, ialfald de tidligere, ikke uden videre kunne sammenstilles, med mindre de benyttede Instrumenter — hvad her ikke er Tilfældet — ere blevne directe sammenlignede, og da det let kan hænde, at det System, som et Aars Observationer giver, er noget forskjelligt fra et andet Aars — hvad der i det foreliggende Tilfælde synes at finde Sted — har jeg anstillet en directe Sammenligning mellem de tyske Observationer fra Overfladen og de norske for Strækningen fra Nordsøen til Jan Mayen. Den fundne Forskjel, anbragt som Correction til

[1] Det vilde til det Øjemed, hvortil saadanne Observationer her ere benyttede, nemlig Beregning af Trykket i Dybet, saavelsom til klimatologiske Øjemed, være bedre at tage Vandprøverne fra et Dyb af 1 à 2 Meter.

[2] Zweite Deutsche Nordpolfahrt, II. 7. Aräometerbeobachtungen. Bearbeitet von C. Börgen. S. 667.

gravity of sea-water at $\frac{17^{\circ}.5}{17^{\circ}.5}$, I have applied precisely as the sea-temperatures for the construction of maps showing its distribution at the surface and the bottom, as also for vertical transverse sections. These represent together the distribution of specific gravity, or the proportionate amount of salt found in a horizontal or vertical direction throughout the North Ocean. During the progress of this work various discrepancies made their appearance, that had to be eliminated, and for which I shall account.

Off the coast of Norway, from Stad to Lofoten, the direct observations set forth in Tornøe's Map exhibit at the surface very sinuous lines for an equal proportion of salt. These I have seen fit to equalize, and have drawn my lines along the coast (Pl. XXXIV) without giving them any considerable curvature. The determinations of specific gravity at the surface have been made with water taken from the surface itself. Here, divers causes, such as precipitation, rapid evaporation, may easily occasion local and temporary deviations from the normal proportion of salt.[1]

In 1877 and 1878, the amount of salt was determined both by the areometer and by the amount of chlorine. As will appear from Tornøe's Tables, the results of the two methods exhibit as a rule very satisfactory agreement. In such cases, I took the mean of both, after first converting, according to Tornøe's mode of procedure, the figures in his Column: — *Amount of Salt by the Amount of Chlorine* to Spec. Gravity at $\frac{17^{\circ}.5}{17^{\circ}.5}$. In some cases, the deviation is rather considerable between the areometer and the chlorine determinations. By means of the maps and the transverse sections, I could see at a glance which of the determinations agreed best with the system based on the other observations; and this was chosen, to the exclusion of the other, whether a chlorine or an areometer-determination.

Since it was of interest the system should be extended to different parts of the North Ocean which our Expedition had no opportunity of traversing, I sought to supply the deficiency by means of observations from other Expeditions. First in this respect stands the second German Arctic Expedition.[2] Since the areometer-observations from various Expeditions — at least the earlier — will not admit of comparison unless the instruments made use of — which was not the case with ours — had been directly compared; and as it can easily happen that the system resulting from one year's observations may be somewhat different to that from another year's — which indeed would seem to have occurred in the present case — I instituted a direct comparison between the German observations from the surface and the Norwegian for the tract extending from the North

[1] For the purpose to which such observations are here applied, viz., computing the pressure in the deep, as also for certain climatological studies, it would be better to take the samples of water from a depth of one or two metres beneath the surface.

[2] Zweite Deutsche Nordpolfahrt, II, 7. Aräometerbeobachtungen. Bearbeitet von C. Börgen. Page 667.

de tyske Observationer, reducerer disse til det af vor Expedition fundne System. Saaledes fandt jeg en særdeles velkommen Anledning til at udvide Systemet til Farvandet mellem Jan Mayen og Østgrønland (Tversnittene XVII og XIX, Pl. XXXVII. Stat. H_I, H_{II}, H_{III} og G_I, G_{II}, G_{III}). De af den tyske Expedition bestemte Værdier for den specifiske Vægt i Overfladen indtegnedes paa Kartet, og de Ujevnheder, der viste sig, elimineredes, idet der toges Middeltallet af Grupper for flere Dages Observationer, og de mellem disse Tal løbende, tildels ujevnt fordelte, Linier for ligestor specifisk Vægt omsattes til det mere regelmæssige System, som er fremstillet i Kartet Pl. XXXIV. Efter de Observationer fra den tyske Expedition, der give den specifiske Vægts Tilvæxt med Dybet [1], construeredes i Tversnittene XVII og XIX, Pl. XXXVII, Linierne for lige specifisk Vægt i Dybet. Det skal ikke nægtes, at denne Tilslutning af de tyske Observationer til vort System ikke er fri for nogen Vilkaarlighed i Detaljen. Men i det Store taget tror jeg, at den giver en Fremstilling af de normale Forhold saa nøjagtig, som Omstændighederne tillade.

Fra "Porcupine" Expeditionen i 1869 foreligge Observationer af den specifiske Vægt fra to Steder i Færø-Shetland-Renden [2]. Disse ere, paa lignende Maade som de tyske, blevne reducerede til vort System, idet Overfladens specifiske Vægt er antaget at være 1.0270. De ere i det Følgende betegnede med P. 64 og P. 54. Beklageligvis foreligge ikke flere saadanne Observationer fra Dybet i dette interessante Strøg.

Den specifiske Vægt i den nordre Del af Nordsøen har jeg taget efter Pommerania-Expedionen [3], efter A. Helland [4], hvis Chlorbestemmelser her ere af saameget større Værd, som de ere tagne 0.3 Meter under Overfladen, og efter K. J. V. Steenstrup [5]. Derhos har jeg benyttet Observationerne af Saltmængden fra de danske Fyrskibe Horns Rev og Skagens Rev [6].

Endelig har jeg med stor Fordel kunnet benytte Observationer fra Nordenskiølds Rejse i Østhavet med

[1] L. c. S. 683, 684.

[2] The Depths of the Sea, by C. Wyville Thomson. S. 513.

[3] Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Nordsee im Sommer 1872. I. Zur Physik des Meeres v. Dr. H. A. Meyer.

[4] Amund Helland. Om Klormængden i Nordsøen, Atlanterhavet og Davisstrædet. Archiv for Mathematik og Naturvidenskab, I Bd. 1876.

[5] Overfladevandets Varmegrad, Saltmængde og Farve i Atlanterhavet paa c. 59° Nord-Brede. Af videnskabelige Meddelelser fra den naturhistoriske Forening i Kjøbenhavn 1877—78.

[6] Meteorologisk Aarbog, udgivet af det danske meteorologiske Institut.

Sea to Jan Mayen. The difference found, when applied as a correction to the German observations, reduces these to the system obtained by our Expedition. Thus I chanced to light upon a most fortunate opportunity of amplifying the system as far as the tract of the ocean between Jan Mayen and East Greenland (Sections XVII and XIX, Pl. XXXVII, Stations H_I, H_{II}, H_{III} and G_I, G_{II}, G_{III}). The values determined by the German observers for the specific gravity at the surface, were entered in the map and all inequalities eliminated, the mean being taken of groups for several days' observations; and the lines drawn between these figures to show the same specific gravity, in part unequally distributed, were transposed to the more regular system set forth in the map, Pl. XXXIV. From the observations of the German Expedition giving the increase of specific gravity with depth, [1] were constructed in transverse sections XVII and XIX, Pl. XXXVII, the lines for equal specific gravity in the deep. It cannot be denied that such an approximation of the German observations to our system is certainly, as to the details, somewhat arbitrary. But on the whole, I think it gives a representation of the normal conditions as accurate as circumstances will admit of.

From the "Porcupine" Expedition in 1869, we have observations of specific gravity taken at two Stations in the Færoe-Shetland Channel. [2] As with the German observations, these have been reduced to our system, the specific gravity at the surface being assumed at 1.0270. In the sequel, they are indicated by P. 64 and P. 54. Unfortunately, these are the only observations from the deep throughout this interesting tract.

The specific gravity in the northern part of the North Sea, I have taken from the observations of the "Pommerania" Expedition, [3] from those of A. Helland, [4] whose chlorine-determinations have here so much greater value seeing they were taken 0.3 metre beneath the surface, and from those of K. J. V. Steenstrup. [5] Moreover, I have made use of the observations on the amount of salt from the Danish light-ships "Horns Rev" (Horn's Reef) and "Skagens Rev" (Scaw's Reef). [6]

Finally I have derived great advantage from the observations taken on Nordenskiølds Voyage in the Barents

[1] Ibid. pp. 683, 684.

[2] The Depths of the Sea, by C. Wyville Thomson, p. 513.

[3] Die Expedition zur physikalisch-chemischen und biologischen Untersuchung der Nordsee im Sommer 1872. I. Zur Physik des Meeres v. Dr. H. A. Meyer.

[4] Amund Helland. Om Klormængden i Nordsøen, Atlanterhavet og Davisstrædet. Archiv for Mathematik og Naturvidenskab, I Bd., 1876.

[5] Overfladevandets Varmegrad, Saltmængde og Farve i Atlanterhavet paa c. 59° Nord-Brede. Af videnskabelige Meddelelser fra den naturhistoriske Forening i Kjøbenhavn, 1877—1878.

[6] Meteorologisk Aarbog, udgivet af det danske meteorologiske Institut.

"Vega" i 1878[1] og med "Sofia" til Grønland i 1883[2]. De sidste give den specifiske Vægt i den vestre Del af Danmarkstrædet og tillade saaledes at føre Kartets (Pl. XXXIV) Linier for den Grønlandske Polarstrøm helt fra den 75. Breddegrad (de tyske Observationer) til Kartets Grændse i Nordvest for Island.

De Observationer fra vor Expedition, der ere benyttede til Constructionen af det i Pl. XXXIV til XXXVIII fremstillede System af de specifiske Vægters Fordeling, har jeg sammenstillet i den følgende Tabel.

a er Aræometerbestemmelser, *c* Chlorbestemmelser, *m* Medium af begge, og *i* efter Diagrammerne interpolerede Værdier. $S = 680$ betegner en spec. Vægt af 1.02680.

Sea with the "Vega," in 1878,[1] and on his Voyage with the "Sofia" to Greenland, in 1883.[2] The latter give the specific gravity in the western part of Denmark Strait, and thus admit of extending the lines of the map (Pl. XXXIV) for the Greenland Polar Current from the very limits of the 75th parallel of latitude (the German observations) to the boundary of the map, north-west of Iceland.

The observations from our Expedition applied for the construction of the system of the distribution of specific gravity, represented in Pl. XXXIV to Pl. XXXVIII, I have collated in the following Table: —

a denotes areometer-determinations, *c* chlorine-determinations, *m* medium of both, and *i* values interpolated according to the diagrams. $S=680$, represents a spec. gravity of 1.02680.

Den specifiske Vægt ved $\frac{17^0.5}{17^0.5}$

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.		Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
14	0	680	*a*	143	0	589	*m*
	226	680	*a*		189	668	*m*
24	0	600	*a*	152	0	560	*a*
	90	600	*a*		70	585	*a*
26	0	590	*a*		125	620	*a*
32	430	670	*a*	162	795	664	*m*
33	525	720	*a*	171	0	580	*a*
34	587	700	*a*		642	650	*a*
37	309	690	*a*	176	0	580	*a*
	690	700	*a*	179	0	655	*m*
40	0	685	*a*		1607	657	*c*
	515	670	*a*	183	0	676	*m*
51	0	650	*a*	184	0	669	*m*
	515	665	*a*		600	653	*m*
	1163	665	*a*		1547	653	*m*
52	0	680	*a*	187	1335	665	*m*
	515	675	*a*	189	0	635	*m*
	1861	670	*a*		860	655	*m*
94	0	450	*a*	200	0	650	*a*
	145	490	*a*		620	673	*m*
95	0	420	*a*	206	0	656	*m*
	175	640	*a*		700	665	*m*
96	0	660	*a*		1248	660	*m*
	805	660	*a*	212	0	605	*m*
97	683	680	*a*		142	664	*c*
98	388	655	*a*	213	0	678	*m*
99	213	650	*a*		1760	669	*m*
101	0	630	*a*	215	0	670	*m*
	223	660	*a*		200	670	*m*
104	162	670	*a*		700	659	*m*
125	0	669	*m*		1665	656	*m*
	700	657	*m*	217	0	620	*a*
137	0	570	*a*	226	0	605	*m*
	400	660	*a*		340	645	*i*

Specific Gravity at $\frac{17^0.5}{17^0.5}$.

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.		Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
243	0	670	*m*	289	0	665	*a*
	600	653	*m*		219	665	*a*
	1385	652	*m*	291	0	659	*m*
245	0	680	*a*		194	672	*m*
247	0	684	*c*	293	0	621	*c*
	500	653	*m*		95	604	*m*
	1120	650	*m*	294	0	633	*c*
249	1063	660	*m*		637	656	*c*
254	0	530	*m*	295	0	665	*a*
	70	637	*m*		100	664	*m*
	140	660	*m*		600	658	*c*
262	0	634	*m*		1110	658	*m*
	148	651	*m*	296	100	660	*m*
263	121	648	*m*		600	661	*m*
264	0	645	*m*	297	0	634	*m*
	86	658	*m*		1280	637	*m*
268	0	650	*a*	298	0	630	*a*
	130	661	*m*		1500	629	*c*
270	0	655	*a*	299	0	586	*m*
	136	665	*m*	300	0	477	*m*
272	113	660	*m*	302	0	595	*c*
273	0	660	*m*	303	0	621	*m*
	197	664	*m*		150	647	*m*
275	0	650	*a*	304	300	645	*m*
	147	661	*m*		1735	630	*a*
278	0	640	*a*	305	0	652	*m*
	230	640	*a*	306	0	649	*c*
280	0	640	*a*		1334	633	*m*
	35	650	*a*	310	0	651	*m*
281	0	660	*a*		1006	647	*m*
	115	663	*c*	316	0	604	*m*
284	0	664	*c*		129	652	*m*
286	447	660	*a*	321	25	575	*a*

[1] Contributions to the Hydrography of the Siberian Sea. By Otto Petterson.

[2] Hydrografisk-kemiska Iagttagelser under den svenska Expeditionen til Grønland 1883 af Axel Hamberg. I.

[1] Contributions to the Hydrography of the Siberian Sea. By Otto Petterson.

[2] Hydrografisk-kemiska Iagttagelser under den svenska Expeditionen til Grønland 1883 af Axel Hamberg. I.

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
323	0	664	*m*
	223	652	*m*
326	0	595	*m*
	123	650	*m*
328	0	620	*m*
	200	656	*m*
332	1149	640	*a*
334	0	640	*m*
	403	660	*a*

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
335	0	624	*m*
	179	650	*i*
339	0	552	*m*
	37	630	*i*
342	0	647	*m*
	523	647	*i*
344	0	610	*a*
347	0	631	*m*
	1429	639	*i*

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
349	0	585	*a*
	1487	637	*i*
350	0	557	*m*
	300	635	*m*
	1686	630	*c*
352	0	604	*m*
	300	638	*m*
355	0	580	*a*
	948	638	*m*
357	0	455	*a*

Stat. No.	Dybde Favne (*Depth*) (*Fms.*)	S.	
359	0	575	*a*
	416	647	*m*
361	0	623	*m*
	905	621	*m*
362	0	624	*m*
	459	639	*c*
363	0	600	*a*
	260	656	*m*
368	0	540	*a*
	315	658	*c*

Kartet Pl. XXXIV viser Fordelingen af den specifiske Vægt ved $\frac{17^0.5}{17^0.5}$ i Havets Overflade. Det er væsentlig det samme som Tornøes Kart No. 1, udjevnet og udvidet. Som man ser, har Liniernes Løb paa dette Kart megen Lighed med Isothermernes Løb paa Kartet Pl. XVI, der fremstiller Aarets Middeltemperatur. Til de højere Temperaturer svarer en højere specifisk Vægt, en højere Saltholdighed. Den højeste specifiske Vægt findes i Atlanterhavet, hvor den er over 1.0270. Herfra skyde Linierne for lige specifisk Vægt sig i Form af Tunger op over det norske Hav, med Tendents til Udvidelse henimod Jan Mayen. Tungernes Axe ligger vestligere end Temperaturens. Tungerne fortsætte videre ind i Østhavet, og udenfor Spidsbergens Vestkyst. Tunger med mindre specifisk Vægt trænge frem mellem Jan Mayen og Spidsbergen og i Jan Mayen-Renden. Udenfor Islands Vest- Nord- og tildels Østkyst ligge Tunger med saltere Vand. Et fælles Træk er, at den specifiske Vægt overalt formindskes henimod Kysterne. Her ville Elvene og den større Nedbørmængde stadig tilføre Havoverfladen ferskt Vand, medens Fordunstningen er større over Havet, hvor Vinden udfolder en større Hastighed. Det samme finder Sted henimod de islagte Dele af Havet, hvor Fordunstningen er ringe, Temperaturen lav, den relative Fugtighed stor og Vindhastigheden svækket, og hvor Isens Smeltning afgiver ferskt Vand til Havoverfladen.

Kartet Pl. XXXV viser Fordelingen af den specifiske Vægt ved Havbunden. Ogsaa her er der merkelige Overensstemmelser med Temperatur-Kartet Pl. XXV. I Færø-Shetland-Renden og nordenfor dens Munding er iskoldt Vand med meget høj Saltholdighed. Dette iskolde Vand har dog intet Minimum af Temperatur, idet det er koldere længere Nord. Imellem Jan Mayen og Norge, ved den 70. til 71. Breddegrad, finde vi Maxima baade af Temperatur og af Saltholdighed. Udenfor disse skyde sig fra Jan Mayen-Renden og, paa deres Østside, fra Nord Tunger med lavere Temperatur og ringere Saltholdighed. En lang smal Tunge med højere Saltholdighed og højere

The map, Pl. XXXIV, shows the distribution of the specific gravity, temp. $\frac{17^0.5}{17^0.5}$, at the surface of the sea. It is essentially the same as Tornøe's map, No. 1, equalized and extended. As will be seen, the course of the lines on this map has considerable resemblance to the course of the isotherms on the map Pl. XVI, representing the mean annual temperature. To the higher temperature corresponds a higher specific gravity, i. e., a larger amount of salt. The highest specific gravity is met with in the Atlantic Ocean, where it reaches upwards of 1.0270. From thence the lines for equal specific gravity shoot up in the form of tongues over the Norwegian Sea, with a tendency to expand as they approach Jan Mayen. The axis of the tongues lies more to the west than does that of the temperature. The tongues extend farther into the Barents Sea and off the west coast of Spitzbergen. Tongues having less specific gravity press onward between Jan Mayen and Spitzbergen and through the Jan-Mayen Channel. Off the west, north, and partly the east coast of Iceland, lie tongues of salter water. A common feature is that of the specific gravity everywhere diminishing in proximity to the coasts. Here the rivers and a greater amount of precipition continually furnish the surface of the sea with fresh water, whereas farther out evaporation increases, the wind exhibiting greater velocity. The same phenomenon may be observed near the ice-covered portions of the sea, where evaporation is tardy, temperature low, the relative humidity considerable, and the velocity of the wind impaired, and where, too, the melting of the ice brings an accession of fresh-water to the surface.

The map, Pl. XXXV, shows the distribution of the specific gravity at the sea-bottom. Here, too, remarkable agreement is exhibited with the Map of Temperature, Pl. XXV. In the Færoe-Shetland Channel, as also north of its mouth, we find ice-cold water containing a very considerable proportion of salt. This ice-cold water has, meanwhile, no minimum of temperature, the water being colder still farther north. Between Jan Mayen and Norway, at the 70th to the 71st parallel of latitude, occur maxima of both temperature and saltness. As boundaries of these maxima, extend from the Jan-Mayen Channel, and, on their east side, from the north, tongues with a lower temperature and a less amount

Temperatur skyder sig op langs Spidsbergens Vestkyst. Østhavets Bund dækkes af forholdsvis varmt og saltholdigt Vand.

Paa Pl. XXXVI til XXXVIII er fremstillet den specifiske Vægts Fordeling i Dybet i de samme større verticale Tversnit som Temperaturen i Pl. X til XIV. Tversnittene for den specifiske Vægt ere nummererede med samme Tal som de for Temperaturen.

I Tversnit VIII, Pl. XXXVI, mellem Berufjord paa Island og Christiansund, se vi den højeste specifiske Vægt, 1.0270, ved Mundingen af Færø-Shetland-Renden, fra Overfladen til Bunden. Henimod Norges Kyst aftager den specifiske Vægt, og er højere i Dybet end i Overfladen. Det samme finder Sted henimod Island, men i meget svagere Grad.

Tversnit X gaar fra Langanes paa Island til den 65. Breddegrad ved Norges Kyst. Snittets østligste Del er ført op paa noget højere Bredde (Tversnit XI, Pl. X) end Temperatursnittet Pl. X, da der i dette mangler Maalinger af den specifiske Vægt. Den højeste specifiske Vægt i dette Tversnit er noget over 1.0268, og denne er indskrænket til de øvre Lag; mod Dybet aftager den specifiske Vægt meget langsomt. Mod Øst og mod Vest aftager den og bliver under Kysterne lavest i Overfladen.

I Tversnit XIII, fra Jan Mayen-Renden til Trænan, er det af Linien for den specifiske Vægt 1.0268 omsluttede Rum end mere indskrænket. Linien for 1.0267, der i det forrige Tversnit naaede Bunden i Midten af Havet, er her løftet op til 300 Favnes Dyb. I dette Tversnit er der aabenbart kommet mindre saltholdigt Vand ind fra Jan Mayen-Renden i dybere Lag. Over de norske Kystbanker ligger der ferskere Vand øverst.

Tversnit XV, Pl. XXXVII, gaar fra Jan Mayen til Vesteraalen. Linien for den specifiske Vægt 1.0267, der i forrige Tversnit kun naaede til 300 Favnes Dyb, sænker sig her til 1600 Favnes Dyb og naar næsten Bunden i Havets Midte. Til begge Sider aftager den specifiske Vægt, sterkest under Kysterne af Norge og Jan Mayen (Polarstrømmen).

Tversnit XVII, fra Grønland til Loppen, har sit Maximum af specifisk Vægt, over 1.0266, i den østre Del af Havet. Lignende Forhold finder Sted i de følgende Snit. Det er ved Havbundens østre Skraaninger, at det salteste Vand findes, og under Overfladen. I Temperaturens Fordeling have vi noget tilsvarende, dog ligger Temperaturens Maximum højere, nærmere Overfladen, end den specifiske Vægts.

I Tversnit XIX, fra Grønland til Beeren Eiland, ligger Maximum af specifisk Vægt udenfor Bankens Skraaning strax i Vest for Beeren Eiland og naar, i c. 350 Favnes Dyb, til lidt over 1.02653. Den specifiske Vægt aftager

of salt. A long, narrow tongue having a higher proportion of salt and a higher temperature shoots up along the west coast of Spitzbergen. The bed of the Barents Sea is covered with comparatively warm and salt water.

In Pl. XXXVI to Pl. XXXVIII, is represented the distribution of specific gravity in the deep throughout the same larger vertical sections as temperature in Pl. X to Pl. XIV. The sections for specific gravity are numbered with the same figures as those for temperature.

In transverse section VIII, Pl. XXXVI, between Berufjord in Iceland and Christiansund, we have the highest specific gravity, viz., 1.0270, at the mouth of the Færoe-Shetland Channel, from the surface to the bottom. Towards the coast of Norway, the specific gravity is found to diminish, and to be higher in the deep than at the surface. The same takes place towards Iceland, though to a much less extent.

Transverse section X extends from Langanes, Iceland, to the coast of Norway at the 65th parallel of latitude. The most easterly part of the section has been directed to a somewhat higher latitude (Transverse Section XI, Pl. X) than the section for temperature, Pl. X, since measurements of specific gravity are wanting in the latter. The highest specific gravity in this transverse section rises to a little above 1.0268, and is confined to the upper strata; towards the deep, the specific gravity diminishes very slowly. Towards the east and towards the west it also diminishes, becoming off the coasts lowest at the surface.

In transverse section XIII, from the Jan-Mayen Channel to Trænan, the space enclosed by the line for a specific gravity of 1.0268 is still more circumscribed. The line for 1.0267, which in the former transverse section reached the bottom in the middle of the sea, rises up here to a depth of 300 fathoms. Into this transverse section, less salt water has apparently found its way from the Jan-Mayen Channel in the deeper strata. Over the Norway coastal banks, water with a less proportion af salt lies uppermost.

Transverse section XV, Pl. XXXVII, extends from Jan Mayen to Vesteraalen. The line for a specific gravity of 1.0267, which in the former transverse section did not reach lower than 300 fathoms, attains here a depth of 1600, and sinks to well-nigh the bottom in the middle of the sea. On both sides, the specific gravity diminishes most rapidly off the coasts of Norway and Jan Mayen (the Polar Current).

Transverse section XVII, from Greenland to Loppen, has its maximum of specific gravity, viz., upwards of 1.0266, in the eastern part of the sea. Similar conditions are observed in the following sections. It is along the eastern declivities of the sea-bed that the saltest water occurs, and below the surface. In the distribution of the temperature, we meet with something akin, though the maximum of temperature lies higher, rather more in proximity to the surface, than does that of specific gravity.

In transverse section XIX, from Greenland to Beeren Eiland, the maximum of specific gravity lies off the declivity of the bank, immediately to the west of Beeren Eiland, and reaches, at a depth of about 350 fathoms, a

mod Overfladen, mod Dybet, mod Øst og mod Vest. I Grønlandshavets Overflade er der først, ligesom i det forrige Tversnit, en rask Aftagen der, hvor Sommeren har smeltet Vinterens Is, derpaa en langsom Aftagen henimod Grønlands Kyst der, hvor Drivisen ligger. Dette Forhold fremgaar af den tyske Nordfarts Iagttagelser. Man ser det ogsaa paa Overfladekartet, Pl. XXXIV.

Tversnit XXII, Pl. XXXVIII, fra Grønlandshavet til Spidsbergens Sydkap, viser Maximum af specifisk Vægt, over 1.0265, i c. 400 Favnes Dyb ved Skraaningen af Spidsbergbanken. Den specifiske Vægt aftager langsomt med Dybet, men raskt mod Overfladen under Spidsbergen og i Grønlandshavet.

Tversnit XXIII, udenfor Isfjorden paa Spidsbergen, viser ganske lignende Forhold, ligesaa Tversnit XXV paa den 80. Breddegrad. Omraadet for Linien for 1.0265 er mere og mere indskrænket.

Ligesom Temperaturens Maxima i Tversnittene antydede Strømningernes Vej, saaledes ogsaa de beskrevne Maxima af specifisk Vægt. Den højere Temperatur og den større Saltholdighed følges ad, fra Atlanterhavet til Spidsbergen.

Snittet XXVIII, Pl. XXXVIII, er et Længdesnit langs Greenwich's Meridian. Det salteste Vand, 1.0270, lægger sig fra Shetland ned over Skraaningen i det norske Havs Dyb. Under 68° til 69° Bredde kommer mindre saltholdigt Vand frem over Bunden. I 70° til 71° Bredde sænker saltere Vand sig ned mod Bunden. Under 74° Bredde er saltfattigere Vand gjennem hele Dybet, under 76° til 77° igjen saltrigere. I Pl. XIV, Snit XXVIII, gjenfinder man analoge Forhold i Temperaturens Fordeling.

Det her beskrevne System af de specifiske Vægters Fordeling i vort Nordhav grunder sig hovedsagelig paa vore Observationer af samme fra Overfladen og fra Bunden. Fra intermediære Dybder er desværre Iagttagelsernes Antal forholdsvis lidet. Deres Betydning for Studiet af Havstrømmene stod mig dengang, da Expeditionen arbejdede i Søen, ikke saa klart som nu, og den anvendte Vandhenter var noget besværlig at bruge, hvad der bevirkede, at den sjeldnere anvendtes paa intermediære Dyb. Imidlertid vil man se af Snittene, hvor de benyttede Værdier af den specifiske Vægt ere paaskrevne, at det i de fleste Tilfælder har været muligt at trække Linierne efter virkelige Iagttagelser. Hvor disse have slaaet fejl, giver Temperaturens Fordeling Fingerpeg, og saaledes tør den Fremstilling, jeg har kunnet give af den specifiske Vægts Fordeling i vort Nordhav, som et første Forsøg betragtet, være af Interesse og brugbar til derpaa at grunde videre Beregninger.

little over 1.02653. The specific gravity diminishes towards the surface, towards the deep, towards the east, and towards west. Along the surface of the Greenland Sea, occurs first, as in the previous transverse section, a rapid diminution where the heat of summer has melted the ice of winter; then a slow decrease towards the coast of Greenland, across the tract covered with drift-ice. This fact is proved by the observations of the German Arctic Expedition. It appears likewise from the Surface-Map, Pl. XXXIV.

Transverse Section XXII, Pl. XXXVIII, from the Greenland Sea to South Cape Spitzbergen, exhibits the maximum of specific gravity, upwards of 1.0265, at a depth of about 400 fathoms, on the declivity of the Spitzbergen Bank. The specific gravity diminishes slowly towards the deep but rapidly towards the surface off the coast of Spitzbergen and in the Greenland Sea.

Transverse section XXIII, off Ice Sound Spitzbergen, exhibits precisely similar conditions. Likewise transverse section XXV, on the 80th parallel of latitude. The area within the line for 1.0265 becomes more and more confined.

Precisely as the maxima of temperature in the transverse sections indicated the direction of the currents, so it is with the above-described maxima of specific gravity. The higher temperature and the greater amount of salt are found to correspond with each other from the Atlantic Ocean to Spitzbergen.

Section XXVIII, Pl. XXXVIII, is a longitudinal section, stretching along the meridian of Greenwich. The saltest water, 1.0270, descends from Shetland down the declivity into the deep of the Norwegian Sea. From the 68th to the 69th parallel of latitude, water with a less proportion of salt extends over the bottom. Between the 70th to the 71st parallels of latitude, salter water sinks towards the bottom. On the 74th parallel of latitude, water with a less amount of salt is found to extend throughout the whole deep, and again from the 76th to the 77th salter water. In Pl. XIV, section XXVIII, analogous conditions occur in the distribution of temperature.

The system described above for the distribution of specific gravity in the North Ocean is based chiefly on our observations of samples from the surface and from the bottom. From intermediate depths, the number of observations is, I am sorry to say, comparatively small. The importance of such for the study of ocean-currents, was not so clear to me at the time the Expedition continued working in the sea; and moreover the water-bottle in use proved somewhat heavy, a circumstance that led to its being comparatively seldom employed for intermediate depths. Meanwhile, it will appear from the sections, on which the applied values of specific gravity are inscribed, that, in the majority of cases, the lines have admitted of being drawn from actual observations. Where such failed, the distribution of the temperature gave the required hints; and thus the statement I have given of the distribution of specific gravity in the North Ocean will prove, as a first

attempt, of due interest, and well calculated to serve as the basis of further computations.

6. Havvandets Tæthed.

Til Beregningen af Trykket i et Punkt i Havets Dyb maa man kjende Havvandets specifiske Vægt i de højere liggende Punkter i samme Verticallinie, henført til den stedfindende Temperatur og rent Vand af 4° C. Jeg benævner denne Størrelse for Kortheds Skyld Havvandets Tæthed.

For at reducere Havvandets specifiske Vægt ved 17°.5 C, henført til rent Vand af samme Temperatur, hvilken betegnes ved $S\,\frac{17°.5}{17°.5}$ og er den, som er fremstillet i de i forrige Stykke beskrevne Karter og Tversnit, til dets Tæthed ved Temperaturen $t°$, hvilken jeg kalder $S\,\frac{t°}{4°}$, har jeg gaaet frem paa følgende Maade.

Kaldes den specifiske Vægt S, Volumet af rent Vand V, af Havvandet v, og betegner Tælleren i de vedføjede Brøker den stedfindende Temperatur, Nævneren Temperaturen af det rene Vand, til hvilket den specifiske Vægt henføres, saa har man

6. Density of the Sea-Water.

To compute the pressure at a point in the depth of the sea, we must know the specific gravity of the sea-water at the higher-lying points in the same vertical line, referred to the existing temperature and to pure water of 4° C. I call this quantity, for the sake of brevity, *Density* of Sea-water.

For reducing the specific gravity of sea-water at 17°.5 C, as referred to pure water of the same temperature, denoted by $S\,\frac{17°.5}{17°.5}$, and which is that represented in the maps and sections described in the former chapter, to its density at temperature $t°$, which I call $S\,\frac{t°}{4°}$, I have had recourse to the following mode of procedure.

If we term the specific gravity S, the volume of pure water V, of sea-water v, and if the numerators of the subjoined fractions indicate the existing temperature, the denominators the temperature of the pure water to which the specific gravity is referred, we have

$$S\,\frac{17.5}{4} = S\,\frac{17.5}{17.5} \cdot \frac{V_4}{V_{17.5}}; \quad S\,\frac{t}{4} = S\,\frac{17.5}{4} \cdot \frac{v_{17.5}}{v_t} = S\,\frac{17.5}{17.5} \cdot \frac{V_4}{V_{17.5}} \cdot \frac{v_{17.5}}{v_t} = S\,\frac{17.5}{17.5} \cdot \frac{V_4}{V_{17.5}} \cdot \frac{v_{17.5}}{v_o} \cdot \frac{v_o}{v_t}.$$

Efter (*According to*) Broch[1] er $\frac{V_4}{V_{17.5}} = \frac{0.9998829}{1.0011442} = 0.998740$; log $= 9.994526$.

Efter (*According to*) Tornøe[2] er $\frac{v_{17.5}}{v_o} = 1.00261$.

Altsaa (*Hence*) $S\,\frac{t}{4} = S\,\frac{17.5}{17.5} \times 0.998740 \times 1.00261 \cdot \frac{v_o}{v_t} = 1.00134683 \cdot \frac{v_o}{v_t} \cdot S\,\frac{17.5}{17.5} = a \cdot \frac{v_o}{v_t} \cdot S\,\frac{17.5}{17.5}$.

$$S\,\frac{t}{4} = S\,\frac{17.5}{17.5} + \text{Correction}; \; \text{Corr.} = S\,\frac{t}{4} - S\,\frac{17.5}{17.5} = \left(a \cdot \frac{v_o}{v_t} - 1\right) S\,\frac{17.5}{17.5} = \left(a - \frac{v_t}{v_o}\right) \frac{v_o}{v_t} \cdot S\,\frac{17.5}{17.5}.$$

Størrelsen af $\frac{v_t}{v_o}$ findes i Tornøes Tabel. Den følgende Correctionstabel er beregnet for en Saltholdighed af 3.5 Procent, hvilket ifølge Tornøe giver

$$S\,\frac{17.5}{17.5} - 1 = \frac{3.5}{131.9} = 0.026536 \text{ eller } S\,\frac{17.5}{17.5} = 1.026536,$$

og kan bruges for alle forekommende Værdier af S.

The value of $\frac{v_t}{v_o}$ is given in Tornøe's Table. The following Table of Correction has been computed for a proportion of salt = 3.5 per cent., which, according to Tornøe, gives

$$S\,\frac{17.5}{17.5} - 1 = \frac{3.5}{131.9} = 0.026536 \text{ or } S\,\frac{17.5}{17.5} = 1.026536,$$

and admits of being applied for all occurring values of S.

[1] Volume et Poids spécifique de l'eau pure. Travaux et mémoires du bureau international des poids et mesures.
[2] L. c. S. 52.

[1] Volume et Poids spécifique de l'eau pure. Travaux et mémoires du bureau international des poids et mesures.
[2] Chemistry, p. 52.

Reductionstabel for

Havvandets sp. V. ved $\frac{17^0.5}{17^0.5}$ til sp. V. ved $\frac{t^0}{4^0}$.

Correction for 4de Decimal.

Table of Reduction for

Specific Gravity of Sea-Water at $\frac{17^0.5}{17^0.5}$ to Sp. Grav. at $\frac{t^0}{4^0}$.

Correction to the 4th place of Decimals.

C.	0°.0	0°.1	0°.2	0°.3	0°.4	0°.5	0°.6	0°.7	0°.8	0°.9
-2°	14.7									
-1	14.4	14.4	14.5	14.5	14.5	14.6	14.6	14.6	14.6	14.7
-0	13.9	14.0	14.0	14.1	14.1	14.2	14.2	14.3	14.3	14.4
+0	13.9	13.8	13.8	13.7	13.7	13.6	13.5	13.5	13.4	13.4
1	13.3	13.2	13.1	13.1	13.0	12.9	12.8	12.7	12.7	12.6
2	12.5	12.4	12.3	12.3	12.2	12.1	12.0	11.9	11.9	11.8
3	11.7	11.6	11.5	11.4	11.3	11.2	11.1	11.0	10.9	10.8
4	10.7	10.6	10.5	10.4	10.3	10.2	10.0	0.9	9.8	9.7
5	9.6	9.5	9.4	9.2	9.1	9.0	8.9	8.8	8.6	8.5
6	8.4	8.3	8.1	8.0	7.9	7.8	7.6	7.5	7.4	7.2
7	7.1	7.0	6.8	6.7	6.5	6.4	6.2	6.1	5.9	5.8
8	5.6	5.5	5.3	5.2	5.0	4.9	4.7	4.6	4.4	4.3
9	4.1	3.9	3.8	3.6	3.5	3.3	3.1	3.0	2.8	2.7
10	2.5	2.3	2.1	2.0	1.8	1.6	1.4	1.2	1.1	0.9
11	0.7	0.5	0.3	0.2	0.0	-0.2	-0.4	-0.6	-0.7	-0.9
12	-1.1	-1.3	-1.5	-1.7	-1.9	-2.1	-2.3	-2.5	-2.7	-2.9
13	-3.1	-3.3	-3.5	-3.7	-3.9	-4.1	-4.3	-4.5	-4.7	-4.9
14	-5.1	-5.3	-5.5	-5.7	-5.9	-6.1	-6.4	-6.6	-6.8	-7.0
15	-7.2	-7.4	-7.6	-7.8	-8.1	-8.3	-8.5	-8.7	-9.0	-9.2
16	-9.4	-9.6	-9.9	-10.1	-10.4	-10.6	-10.8	-11.1	-11.3	-11.6
17	-11.8	-12.0	-12.3	-12.5	-12.7	-12.9	-13.2	-13.4	-13.6	-13.9
18	-14.1	-14.3	-14.6	-14.8	-15.1	-15.3	-15.6	-15.8	-16.1	-16.3
19	-16.6	-16.8	-17.1	-17.3	-17.6	-17.8	-18.1	-18.3	-18.6	-18.8
20	-19.1									

Reductionen af $S\,\frac{17^0.5}{17^0.5}$ til $S\,\frac{t^0}{4^0}$, efter denne Tabel, er udført i de følgende Tabeller for en Række Stationer, nemlig dem, der senere ere benyttede til Beregningen af Trykket i Dybet. Det er de Stationer, paa hvilke der er maalt Temperaturrækker, paa faa Undtagelser nær. Tabellerne have til Overskrift Stationernes Nummer efter Tabellerne Side 44 til 61. Den første Rubrik angiver Dybdeintervallerne, hvert paa hundrede Favne, altsaa 0—1 betegner fra Overfladen til 100 Favnes Dyb o.s.v. Den anden Rubrik angiver Dybdeintervallets Middeltemperatur, efter Temperaturrækkerne og Snittene Pl. IX til XII. Mellem Overfladen og 100 Favnes Dyb er regnet med Aarets Middeltemperatur. Den tredie Rubrik giver den specifiske Vægt ved $\frac{17^0.5}{17^0.5}$ efter Tversnittene Pl. XXXVI til XXXVIII efter Schema: 680 = 1.02680. Den fjerde Rubrik giver Tætheden $S\,\frac{t^0}{4^0}$. Paa flere Steder er Rækken af Tal fortsat videre

The reduction of $S\,\frac{17^0.5}{17^0.5}$ to $S\,\frac{t^0}{4^0}$, according to this Table, has been carried out in the following Tables for a series of Stations, viz., those that have been subsequently made use of for computing the pressure in the deep. The said Stations are those at which serial temperatures were taken, with but very few exceptions. The Tables have for headings the numbers of the Stations in the Table, page 44 to 61. The first Column indicates the intervals of depth, each of one-hundred fathoms; hence 0—1 denotes from the surface to a depth of one-hundred fathoms, etc. The second Column gives the mean temperature of the interval of depth, according to the serial temperatures and the sections, Pl. IX to Pl. XII. Between the surface and a depth of a hundred fathoms, the computation has been made with the mean annual temperature. The third Column gives the specific gravity at $\frac{17^0.5}{17^0.5}$, as shown by the transverse sections, Pl. XXXVI

end til Havbunden, hvortil Grunden senere skal forklares. Det første af saadanne Tal er merket med en Stjerne.

to Pl. XXXVIII, according to the form: 680 = 1.02680. The fourth Column gives the density, $S\frac{t^0}{4^0}$. In several places, the series of figures have been extended deeper than the sea-bed, the reason of which will be subsequently explained. The first of such figures is marked with an asterisk.

14.

	°		
0—1	9.0	680	721
1—2	7.4	680	745
2—3	5.7	680	768
3—4	*0.0	693	832
4—5	—1.0	700	844

24.

	°		
0—1	6.8	600	674
1—2	*7.5	623	687
2—3	6.2	654	735
3—4	4.7	665	764
4—5	0.0	672	811

32.

	°		
0—1	8.8	630	674
1—2	7.6	643	705
2—3	6.2	654	735
3—4	4.7	665	764
4—5	0.0	672	811

34.

	°		
0—1	8.0	704	760
1—2	6.0	709	793
2—3	1.9	710	836
3—4	—0.2	709	849
4—5	—0.5	706	848
5—6	—0.7	701	844
6—7	—1.0	700	844

37.

	°		
0—1	7.7	700	761
1—2	5.8	695	781
2—3	1.8	692	819
3—4	—0.3	690	831
4—5	—0.6	692	834
5—6	—0.8	695	838
6—7	—1.1	697	841

40.

	°		
0—1	7.6	685	747
1—2	5.0	678	774
2—3	1.1	675	807
3—4	0.2	672	810
4—5	—0.3	670	811
5—6	—0.4	669	810
6—7	—0.6	669	811
7—8	—0.7	669	812
8—9	—0.8	669	812
9—10	—1.0	669	813
10—11	—1.1	669	813
11—12	—1.1	669	813
12—13	—1.2	670	815

42.

	°		
0—1	7.9	695	751
1—2	6.5	678	756
2—3	2.4	662	784
3—4	*0.5	663	799
4—5	—0.2	664	804

48.

	°		
0—1	1.3	675	806
1—2	0.0	666	805
2—3	—0.4	660	801
3—4	—*0.5	662	804
4—5	—0.5	664	806

51.

	°		
0—1	0.7	652	787
1—2	0.1	657	795
2—3	—0.2	660	800
3—4	—0.5	662	802
4—5	—0.6	664	806
5—6	—0.6	665	807
6—7	—0.8	665	808
7—8	—0.9	665	809
8—9	—1.0	665	809
9—10	—1.1	665	809
10—11	—1.1	665	809
11—12	—1.1	665	809

52.

	°		
0—1	5.8	681	767
1—2	5.1	681	776
2—3	3.2	680	795
3—4	0.8	678	812
4—5	—0.2	676	816
5—6	—0.5	675	817
6—7	—0.7	674	817
7—8	—0.8	674	817
8—9	—0.9	673	817
9—10	—0.9	673	817
10—11	—1.0	672	816
11—12	—1.0	672	816
12—13	—1.0	672	816
13—14	—1.1	671	815

52 f.

f.	°		
14—15	—1.1	671	815
15—16	—1.1	671	815
16—17	—1.1	671	815
17—18	—1.1	670	814

94.

	°		
0—1	4.9	470	567
1—2	*5.9	620	705
2—3	5.7	680	768
3—4	0.0	693	832
4—5	—1.0	700	844

95.

	°		
0—1	6.3	500	580
1—2	5.9	620	705
2—3	*5.7	680	768
3—4	0.0	693	832
4—5	—1.0	700	844

96.

	°		
0—1	6.5	682	760
1—2	5.8	682	768
2—3	5.4	681	772
3—4	3.5	680	792
4—5	0.5	678	814
5—6	—0.5	676	818
6—7	—0.8	674	817
7—8	—1.0	673	817
8—9	—1.2	660	805

99.

	°		
0—1	7.4	668	733
1—2	6.8	668	742
2—3	5.8	652	738
3—4	*1.0	655	788
4—5	—1.0	660	799

107.

	°		
0—1	5.7	600	688
1—2	6.2	651	732
2—3	*5.7	650	738
3—4	1.0	650	783
4—5	—1.0	655	799
5—6			
6—7			

125.

	°		
0—1	6.1	680	763
1—2	5.1	680	775
2—3	4.0	673	780
3—4	1.5	663	792
4—5	—0.5	659	801
5—6	—1.0	658	802
6—7	—1.1	657	801

137.

	°		
0—1	7.3	660	727
1—2	6.4	672	751
2—3	5.7	667	755
3—4	2.0	666	791
4—5	—1.0	665	809

148.

	°		
0—1	4.9	612	709
1—2	6.2	662	745
2—3	*5.6	667	756
3—4	2.0	666	791
4—5	—1.0	665	809

176 ($\frac{189}{187}$).

	°		
0—1	5.9	640	725
1—2	6.0	662	746
2—3	5.0	663	759
3—4	4.0	661	768
4—5	2.4	659	781
5—6	—0.4	658	799
6—7	—0.8	658	801
7—8	—1.0	657	801
8—9	—1.1	656	800
9—10	—1.1	656	800
10—11	—1.1	656	800

183.

	°		
0—1	5.2	675	769
1—2	4.3	676	780
2—3	3.7	677	787
3—4	3.1	676	792
4—5	2.1	675	799
5—6	0.5	674	800
6—7	—0.3	672	813
7—8	—0.7	671	814
8—9	—0.8	670	813
9—10	—0.9	668	812
10—11	—1.0	667	811

	176 f.			183 f.		
11—12	—1.1	656	800	1.1	666	810
12—13	1.1	656	800	- 1.2	666	811
13—14	- -1.1	656	800	-1.2	665	810
14—15	1.1	656	800	1.2	665	810
15—16				1.2	664	809
16—17				1.2	663	808
17—18				—1.3	663	808

	184.			199 & 200.		
0—1	4.8	671	769	5.6	660	748
1—2	3.6	672	783	4.5	661	764
2—3	3.2	672	787	3.4	661	774
3—4	2.8	672	791	2.4	661	783
4—5	2.1	671	795	1.1	660	792
5—6	0.8	670	804	—0.6	659	801
6—7	0.4	669	810	—1.1	658	802
7—8	0.7	668	811			
8—9	—0.8	666	809			
9—10	0.9	665	809			
10—11	1.0	664	808			
11—12	-1.0	663	807			
12—13	1.1	661	805			
13—14	- -1.2	660	805			
14—15	—1.2	659	804			
15—16	-1.2	858	803			

	206.			213.		
0—1	4.9	660	757	5.1	676	771
1—2	4.0	664	771	4.2	676	781
2—3	3.5	665	777	3.6	676	787
3—4	2.7	666	785	3.3	675	789
4—5	1.4	666	796	2.7	675	794
5—6	0.2	665	803	1.4	674	804
6—7	—0.5	665	807	0.1	673	811
7—8	- 0.8	664	807	—0.5	673	815
8—9	—0.9	664	808	—0.8	672	815
9—10	—1.0	663	807	1.0	672	816
10—11	1.1	662	806	-1.0	672	816
11—12	-1.1	661	805	1.1	671	815
12—13	—1.1	660	804	1.1	670	814
13—14				-1.2	670	815
14—15				—1.2	670	815
15—16				1.2	669	814
16—17				—1.2	669	814
17—18				-1.2	669	814

	215.			217.		
0—1	3.6	670	781	—1.4	645	790
1—2	3.1	670	786	—1.1	651	795
2—3	2.5	670	791	1.3	653	798
3—4	1.6	668	796	—1.2	654	799
4—5	0.2	666	804	1.2	654	799
5—6	-0.3	664	805	1.3	653	798
6—7	0.5	662	804	1.2	652	797
7—8	--0.7	660	803	-1.2	651	796
8—9	0.9	660	804	1.3	650	795
9—10	—1.0	659	803			
10—11	1.1	658	802			
11—12	1.1	658	802			
12—13	1.2	657	802			
13—14	-1.2	657	802			
14—15	1.2	657	802			
15—16	—1.2	656	801			
16—17	1.2	656	801			

	226 (& 227)			241.		
0—1	—0.9	600	744	0.4	642	779
1—2	—0.2	630	770	—0.1	641	781
2—3	— 0.1	640	780	0.4	640	781
3—4	—0.6	642	784	—0.5	640	782
4—5	*1.0	641	785	—0.7	640	783
5—6	—1.1	640	784	—0.8	640	783
6—7	— 1.2	637	782	-1.0	640	784
7—8	-1.3	635	780	-1.0	639	783
8—9	-1.3	633	778	—1.1	639	783
9—10	—1.4	631	776	1.2	639	784
10—11	—1.5	629	775	1.3	639	784
11—12				-1.3	639	784

	243.			245.		
0—1	2.9	667	785	5.0	680	776
1—2	2.6	663	783	3.7	676	786
2—3	1.4	660	790	1.9	670	796
3—4	0.4	657	794	0.3	662	799
4—5	0.2	655	795	--0.2	657	797
5—6	0.6	653	795	0.4	653	794
6—7	0.8	652	795	0.8	653	796
7—8	1.0	652	796	1.0	653	797
8—9	1.0	652	796	—1.0	653	797
9—10	—1.1	652	796	—1.1	652	796
10—11	1.2	652	797	—1.1	652	796
11—12	1.2	652	797	1.2	652	797
12—13	—1.2	652	797	1.2	651	796
13—14	—1.2	652	797	—1.2	651	796
14—15				— 1.2	651	796
15—16				--1.2	651	796
16—17				1.3	651	796
17—18				—1.3	651	796
18—19				—1.3	651	796
19—20				--1.4	651	796

	247.			262.		
0—1	5.9	683	768	2.9	640	758
1—2	4.5	681	783	1.9	647	773
2—3	3.0	675	792	1.9	656	782
3—4	1.2	665	796	0.4	660	797
4—5	—0.1	656	796	-0.4	660	801
5—6	—0.6	653	795			
6—7	-0.9	653	797			
7—8	-1.0	653	797			
8—9	--1.1	652	796			
9—10	-1.2	651	796			
10—11	1.2	650	795			
11—12	—1.2	650	795			

	268.			270.		
0—1	2.1	655	779	1.7	660	787
1—2	—0.8	661	804	2.0	665	790
2—3	1.5	658	787	2.0	665	790
3—4	0.4	660	797	0.4	660	797
4—5	—0.4	660	801	0.4	660	801

	273.			275.		
0—1	3.0	663	780	2.1	655	779
1—2	2.7	666	785	0·0	661	800
2—3	2.1	660	784	-1.6	660	788
3—4	0.4	660	797	0.4	660	797
4—5	0.4	660	801	—0.4	660	801

284.

0—1	4.0	667	774
1—2	3.5	662	774
2—3	2.2	660	783
3—4	1.5	660	789
4—5	0.5	660	796
5—6	—0.5	660	802
6—7	—1.2	659	804
7—8	—1.2	657	802

291.

0—1	4.5	662	764
1—2	3.7	664	774
2—3	3.4	661	774
3—4	2.3	661	787
4—5	1.7	660	787

295.

0—1	3.8	665	774
1—2	2.9	664	782
2—3	2.3	663	786
3—4	1.7	662	789
4—5	0.6	661	796
5—6	—0.6	660	802
6—7	—0.9	660	804
7—8	—1.1	660	804
8—9	—1.2	659	804
9—10	—1.2	659	804
10—11	—1.3	658	803
11—12	—1.3	658	803
12—13			
13—14			
14—15			

296.

0—1	3.4	658	771
1—2	2.8	660	779
2—3	2.3	661	784
3—4	1.7	661	788
4—5	0.5	661	797
5—6	—0.3	661	802
6—7	0.7	661	804
7—8	0.9	660	804
8—9	1.1	658	802
9—10	—1.2	655	800
10—11	—1.2	652	797
11—12	1.2	648	793
12—13	1.3	645	790
13—14	1.3	642	787
14—15	—1.4	642	785

297.

0—1	—0.3	638	779
1—2	—0.1	640	780
2—3	—0.3	641	782
3—4	—0.6	642	784
4—5	—0.9	644	788
5—6	—1.1	645	789
6—7	—1.2	645	790
7—8	—1.3	644	789
8—9	—1.3	644	789
9—10	—1.3	643	788
10—11	1.4	641	786
11—12	—1.4	640	785
12—13	—1.4	638	783
13—14	—1.4	637	782
14—15			
15—16			

298.

0—1	0.5	630	772
1—2	0.2	631	771
2—3	0.7	632	775
3—4	0.9	633	777
4—5	1.0	633	777
5—6	—1.1	634	778
6—7	—1.2	634	779
7—8	1.2	634	779
8—9	—1.3	633	778
9—10	—1.3	632	777
10—11	—1.4	632	777
11—12	—1.4	632	777
12—13	—1.4	631	776
13—14	—1.4	630	775
14—15	1.5	629	775
15—16	1.5	629	775

300.

0—1	—1.0	590	734
1—2	—0.3	600	741
2—3	—0.7	604	747
3—4	—1.0	608	752
4—5	—1.1	610	754
5—6	—1.2	612	757
6—7	—1.3	613	758
7—8	—1.4	614	759
8—9	—1.4	615	760
9—10	—1.4	615	760
10—11	—1.5	615	761
11—12	—1.5	615	761
12—13	—1.6	616	762
13—14	—1.6	617	763
14—15	*1.6	618	764
15—16			
16—17			
17—18			
18—19			
19—20			

302.

0—1	—1.1	605	749
1—2	—1.4	615	760
2—3	—1.4	620	765
3—4	—1.5	624	770
4—5	—1.5	627	773
5—6	—1.5	628	774
6—7	1.6	627	773
7—8	1.6	627	773
8—9	1.6	627	773
9—10	1.6	627	773
10—11	—1.6	627	773
11—12	—1.6	626	772
12—13	1.6	626	772
13—14	—1.6	626	772
14—15	—1.6	625	771
15—16	—1.6	625	771
16—17	—1.6	625	771
17—18	—1.7	625	771
18—19	—1.7	625	771
19—20	—1.7	625	771

303.

0—1	0.9	627	771
1—2	—1.2	640	785
2—3	1.2	642	787
3—4	—1.2	643	788
4—5	1.3	642	787
5—6	1.4	642	787
6—7	1.4	641	786
7—8	1.4	640	785
8—9	—1.5	640	786
9—10	1.5	637	783
10—11	—1.6	634	780
11—12	—1.6	631	777
12—13			
13—14			
14—15			
15—16			
16—17			
17—18			

304.

0—1	—0.5	635	777
1—2	—0.5	643	785
2—3	—0.7	645	788
3—4	0.9	645	789
4—5	1.2	645	790
5—6	—1.2	645	790
6—7	—1.3	644	789
7—8	—1.4	643	788
8—9	1.4	642	787
9—10	—1.5	641	787
10—11	—1.5	638	784
11—12	—1.6	635	781
12—13	—1.6	634	780
13—14	1.6	633	779
14—15	1.6	632	778
15—16	—1.6	631	777
16—17	—1.6	630	776
17—18	1.6	630	776

305.

0—1	1.2	650	781
1—2	0.7	651	786
2—3	0.3	651	788
3—4	0.0	651	790
4—5	—0.5	651	793
5—6	—0.8	650	793
6—7	—0.9	649	793
7—8	—1.0	647	791
8—9	—1.1	645	789
9—10	1.2	643	788
10—11	1.3	641	786
11—12	1.3	639	784
12—13	—1.4	638	783
13—14	1.4	636	781
14—15	—1.5	633	779
15—16	—1.5	632	778

306.

0—1	2.3	652	775
1—2	1.9	653	779
2—3	1.3	653	784
3—4	0.9	653	787
4—5	0.2	652	790
5—6	—0.5	652	794
6—7	—0.7	651	794
7—8	0.8	649	792
8—9	—1.0	647	791
9—10	—1.1	644	788
10—11	1.2	642	787
11—12	1.2	640	785
12—13	1.3	636	781
13—14	1.3	633	778

308.

0—1	2.8	652	771
1—2	2.2	653	776
2—3	1.4	653	783
3—4	1.1	653	785
4—5	0.9	653	787
5—6	0.1	652	790
6—7	0.6	651	793
7—8	—0.9	650	794
8—9	—1.0	647	791
9—10	—1.2	645	790
10—11	1.2	642	787
11—12	1.3	640	785

314.

0—1	3.9	650	758
1—2	3.2	652	767
2—3	2.3	652	775
3—4	1.5	652	781
4—5	0.1	651	789
5—6	—0.5	651	793

323.

0—1	4.0	662	769
1—2	2.9	658	776
2—3	2.0	658	783
3—4	0.4	660	797
4—5	—0.4	660	801

339.

0—1	3.0	600	717
1—2	2.8	631	750
2—3	2.3	650	773
3—4	1.5	650	779
4—5	0.2	650	788

342.

0—1	3.5	641	753
1—2	3.3	647	761
2—3	2.3	650	773
3—4	1.5	650	779

345.

0—1	1.8	642	769
1—2	1.4	649	779
2—3	1.1	651	783
3—4	0.8	651	785

	342 f.			345 f.		
	°			°		
4—5	0.4	650	787	0.0	651	790
5—6	—1.2	647	792	—0.7	651	794
6—7				—1.0	649	793
7—8				—1.1	646	790
8—9				—1.2	643	788
9—10				—1.2	641	786
10—11				—1.3	640	785
11—12				—1.3	639	784

	347.			349.		
	°			°		
0—1	1.7	639	766	—1.0	610	754
1—2	1.4	645	775	—0.6	632	774
2—3	1.1	650	783	—0.9	638	782
3—4	0.8	650	784	—1.0	641	785
4—5	0.3	650	787	—1.2	643	788
5—6	—0.6	650	792	—1.2	643	788
6—7	—0.9	648	792	—1.2	643	788
7—8	—1.0	645	789	—1.3	642	787
8—9	—1.0	643	787	—1.3	641	786
9—10	—1.1	642	786	—1.3	640	785
10—11	—1.1	640	784	—1.3	639	784
11—12	—1.2	639	784	—1.3	639	784
12—13	—1.2	639	784	—1.4	638	783
13—14	—1.3	639	784	—1.4	638	783
14—15	—1.3	639	784	—1.4	637	782
15—16				—1.5	637	783

	350.			351.		
	°			°		
0—1	1.0	570	714	—0.2	560	700
1—2	—0.6	605	751	0.0	590	734
2—3	0.9	631	775	—0.6	603	745
3—4	—1.2	635	780	—1.2	614	759
4—5	—1.4	636	781	—1.3	621	766
5—6	—1.4	637	782	—1.4	624	769
6—7	1.4	637	782	—1.5	626	772
7—8	—1.4	637	782	—1.5	627	773
8—9	—1.5	636	782	—1.5	627	773
9—10	—1.5	635	781	—1.5	627	773
10—11	—1.5	635	781	—1.5	625	771
11—12	—1.5	634	780	—1.5	624	770
12—13	—1.5	633	779	—1.5	623	769
13—14	—1.5	632	778	—1.5	622	768
14—15	—1.5	631	777	—1.5	621	767
15—16	—1.5	630	776	—1.5	620	766
16—17	—1.5	630	776	—1.5	619	765

	352.			$\frac{353 \& 354}{2}$.		
	°			°		
0—1	—0.4	608	749	0.7	627	762
1—2	—0.2	622	762	0.7	640	775
2—3	—0.6	633	775	0.5	644	780
3—4	—1.0	637	781	—0.1	645	785
4—5	—1.3	638	783	—0.7	645	788
5—6	—1.4	639	784	—1.0	644	788
6—7	—1.5	638	784	—1.2	642	787
7—8	—1.5	637	783	—1.2	641	786
8—9	—1.5	635	781	—1.3	639	784
9—10	1.5	634	780	—1.3	638	783
10—11	—1.5	633	779	—1.3	637	782
11—12	—1.5	632	778	—1.3	634	779
12—13	—1.5	631	777	—1.35	633	778
13—14	—1.5	631	777			
14—15	—1.5	630	776			
15—16	—1.5	628	774			
16—17	—1.5	626	772			

	355.			357.		
	°			°		
0—1	1.8	620	747	1.0	500	633
1—2	1.3	640	771	2.0	630	755
2—3	1.0	648	781	1.0	648	781
3—4	0.8	650	784			
4—5	0.3	650	787			
5—6	—0.4	646	787			
6—7	—0.9	644	788			
7—8	—1.2	642	787			
8—9	—1.3	639	784			
9—10	—1.3	638	783			

	361.			362.		
	°			°		
0—1	1.5	622	751	1.9	631	757
1—2	2.0	632	757	2.1	640	764
2—3	1.4	636	766	1.3	641	772
3—4	0.2	640	778	0.4	639	776
4—5	—0.4	638	779	—0.8	635	778
5—6	—0.8	635	778			
6—7	—1.1	633	777			
7—8	—1.2	630	775			
8—9	—1.2	623	768			

	363.			364.		
	°			°		
0—1	2.4	628	750	2.1	615	739
1—2	2.4	642	764	2.3	630	753
2—3	1.3	656	787	1.4	645	775
3—4	0.4	639	776			
4—5	—0.8	638	778			

	368.			371.		
	°			°		
0—1	2.0	610	735	1.0	460	593
1—2	1.8	630	757	1.5	570	699
2—3	1.7	647	774	1.0	648	781
3—4	1.2	660	791	0.8	650	784
4—5	0.2	648	786	0.3	650	787

	P 54.			P 64.		
	°			°		
0—1	9.0	700	741	7.6	700	762
1—2	8.8	700	744	6.1	700	783
2—3	7.8	700	759	1.6	700	828
3—4	2.7	700	819	—0.3	700	841
4—5	0.4	698	839	—0.9	690	834
5—6	—1.2	695	840	—1.2	680	825
6—7				—1.4	670	815

	H_1			G_1		
	°			°		
0—1	—1.0	545	689	—1.0	579	723
1—2	—1.0	581	725	—1.3	600	745
2—3	—1.0	593	737	—1.4	607	752
3—4	—1.0	598	742	—1.4	611	756
4—5	—1.1	601	745	—1.4	614	759
5—6	—1.2	603	748	—1.4	617	762
6—7	—1.3	605	750	—1.4	618	763
7—8	—1.4	607	752	—1.4	619	764
8—9	—1.4	609	754	—1.4	620	765
9—10	—1.4	611	756	—1.4	621	766
10—11	—1.5	612	758	—1.4	622	767
11—12	—1.5	612	758	—1.4	622	767
12—13	—1.6	613	759	—1.4	622	767
13—14	—1.6	613	759	—1.4	622	767
14—15	—1.6	614	760	—1.4	623	768

	H_{II}			G_{II}		
	°			°		
0—1	—1.0	520	664	—1.0	555	699
1—2	—1.0	566	710	—1.3	587	732
2—3	—1.0	585	729	—1.4	597	742
3—4	—1.0	592	736	—1.4	602	747
4—5	—1.1	596	740	—1.4	606	751
5—6	—1.2	600	745	—1.4	609	754
6—7	—1.3	601	746	—1.4	611	756
7—8	—1.4	603	748	—1.4	611	756
8—9	—1.4	606	751	—1.4	612	757
9—10	—1.4	608	753	—1.4	612	757
10—11	—1.5	610	756			

	H_{II} f.		
	°		
11—12	—1.5	611	757
12—13	—1.6	612	758
13—14	—1.6	612	758
14—15	—1.6	612	758

	H_{III}			G_{III}		
	°			°		
0—1	—1.0	515	659	—1.0	528	672
1—2	—1.0	560	704	—1.3	573	718
2—3	—1.0	583	727	—1.4	590	735

Paa Pl. XXXIX til XLI er vist Fordelingen af Havvandets Tæthed i de samme Tversnit som i Pl. XXXVI til XXXVIII.

I Tversnit VIII, Pl. XXXIX, ligger den største Tæthed ved Bunden og er over 1.0285. I det hele taget ligge de tungere Vandlag dybest.

I Tversnit X er det samme Tilfældet, men Tætheden naar ikke højere end mellem 1.0281 og 1.0282.

I Tversnit XIII er Tætheden i Dybet endnu mindre. I dette optræde, i Midten af Havet, Minima paa 1.02795. I disse maa Vandet have en Bestræbelse efter at stige tilvejrs.

I Tversnit XV, Pl. XL, naar Maximumstætheden næsten til Bunds med over 1.0281, altsaa større end i det foregaaende. Her er en Tendents til Synkning i Midten af Havet.

I Tversnit XVII ligger Maximumstætheden paa den østre Skraaning af Havbunden. Den er lidt over 1.0280, mindre end i forrige Snit.

I Tversnit XIX finder lignende Forhold Sted. Maximum rækker ikke til 1.0280.

I Tversnit XXII, XXIII og XXV, Pl. XLI, ligger ogsaa Maximum paa Skraaningen, udenfor Spidsbergen. Dens Værdi aftager mod Nord, og Vandet har her en synkende Tendents.

I Længdesnittet XXVII (Greenwich's Meridian), Pl. XLI, se vi et Maximum af Tæthed (over 1.0284) paa Bundens Skraaning fra Shetland mod Norske-Dybet, et Minimum (under 1.0280) ved 68° til 69° Bredde, et Maximum (over 1.0281) ved 70° til 71° Bredde, et Minimum (under 1.0277) ved 75° Bredde og et Maximum (over 1.0278) ved 77° Bredde. Hvor Havets Vand er lettere end Omgivelserne, maa det have en Bestræbelse efter at stige opad, hvor det er tungere, efter at synke nedad.

Fordelingen af Havvandets Tæthed tyder saaledes hen paa opstigende og nedstigende Bevægelser i samme.

Den virkelige Tæthed, Havvandet har i Dybet, er større end den her beregnede, idet Havvandet er sammentrykkeligt. Denne Omstændighed, som vi senere skulle tage nærmere i Beregning, har ingen merkelig Indflydelse paa Fordelingen af Tætheden i samme Niveau, idet i et saadant Virkningen af Sammentrykningen bliver den samme i hele

Pl. XXXIX to Pl. XLI show the distribution of the density of the sea-water throughout the same transverse sections as in Pl. XXXVI to Pl. XXXVIII.

In Transverse Section VIII, Pl. XXXIX, the greatest density occurs at the bottom, and reaches upwards of 1.0285. On the whole, the heaviest strata lie deepest.

In Transverse Section X, the same is the case; but the density does not reach higher than between 1.0281 and 1.0282.

In Transverse Section XIII, the density in the deep is still less. In this Section occur in the middle of the sea minima of 1.02795. Here, the water must have a tendency to rise towards the surface.

In Transverse Section XV, Pl. XL, the maximum of density reaches almost to the bottom, and attains a trifle over 1.0281; hence it is greater than in the preceding. Here, a tendency to descend occurs in the middle of the Sea.

In Transverse Section XVII, the maximum of density lies on the eastern declivity of the sea-bed. It attains a little over 1.0280, less than in the foregoing Section.

In Transverse Section XIX, similar conditions are found to occur. The maximum does not reach 1.0280.

In Transverse Sections XXII, XXIII, and XXV, Pl. XLI, the maximum also occurs along the declivity, off Spitzbergen. Its value diminishes towards the north, and here the water has a tendency to descend.

In the Longitudinal Section XXVII (meridian of Greenwich), Pl. XLI, we observe a maximum of density, reaching upwards of 1.0284, on the declivity of the bottom, from Shetland towards the Norway Deep, a minimum (under 1.0280) from parallel 68° to parallel 69° N, a maximum (exceeding 1.0281) from parallel 70° to 71° N, a minimum (less than 1.0277) at parallel 75° N, and a maximum (upwards of 1.0278) at parallel 77° N. Where the water of the sea is lighter than that surrounding it, there must be a tendency to rise; where it is heavier, to sink.

The distribution of the density of the sea-water would thus appear to indicate ascending and descending movements in the ocean.

The actual density of the sea-water in the deep is greater than that here calculated, sea-water being compressible. To this circumstance we shall subsequently revert; it has however no appreciable influence on the distribution of density in the same surface of level, since the effect of compression will be the same throughout the whole

Niveauets Udstrækning, og saaledes ingen Indflydelse har paa Vandets Bestræbelse efter at stige op eller synke ned.

7. Trykket i Dybet.

En Atmosfære er Trykket af en Kviksølvsøjle af 0° Temperatur, af 0.76 Meters Højde, ved Havets Overflade under 45° Bredde (Normaltyngden).

Da Kviksølvets specifiske Vægt, henført til rent Vand af 4° C, er, ved 0°, 13.5959, og en engelsk Favn er lig 1,82876694 Meter, saa er, naar Søvandets specifiske Vægt, henført til rent Vand af 4° C. (dets Tæthed) er S,

$$\text{Trykket af 1 Favn Søvand} = \frac{1.82876694}{13.5959} \cdot \frac{S}{0.76}$$

$= 0.1769851\ S$ Atmosfærer

ved Havets Overflade og 45° Bredde.

Størrelsen 0.1769851 kalder jeg a_o; $\log a_o = 9.2479368-10$.

$$\text{Omvendt er 1 Atmosfære} = 1^{at} = \frac{1}{a_o S} = \frac{5.6502}{S}$$

Favnes Tryk.

Trykket af en Favn Søvand er proportionalt med Tyngdens Størrelse. Denne varierer med Bredden og med Dybden under Havets Overflade. Tyngdens Variation med Bredden udtrykkes efter Broch[1] ved Formelen

$$g_\varphi = g_{45}\,(1-\beta\cos 2\,\varphi) \quad \text{hvor } \beta = 0.00259.$$

og hvor g_φ er Tyngden ved Havfladen i Bredden φ, g_{45} Tyngden ved Havfladen i 45° Bredde (Normaltyngden).

Tyngdens Forandring med Dybden i Havet har jeg beregnet paa følgende Maade.

Som Følge af Havvandets Sammentrykkelighed voxer dets Tæthed med Dybden, med Trykket. Kaldes Dybden under Havfladen h, Havvandets Tæthed i Overfladen d_o, og er ε og δ Constanter, saa kan man sætte Tætheden i Dybden h

$$d_h = d_o\,(1+\varepsilon h+\delta h^2)$$

Kaldes Jordens Radius R, har man Massen af et Vandlag med Radius $R-h$, Tykkelse dh og Tæthed d_h

$$dm = 4\,\pi\,(R-h)^2\,d_h\,dh = 4\,\pi\,d_o\,(R-h)^2\,(1+\varepsilon h+\delta h^2)\,dh$$
$$= 4\,\pi\,d_o\,(R^2+R\,(\varepsilon R-2)\,h+(1-2\,\varepsilon R+\delta R^2)\,h^2+(\varepsilon-2\,\delta R)\,h^3+\delta h^4)\,dh.$$

Integreres dette Udtryk mellem Grændserne $h=0$ og $h=h$, faar man Vandlagets Masse fra Overfladen til Dybden h

$$m = 4\,\pi\,d_o\left(R^2 h + \mathrm{R}\,(\varepsilon R-2)\frac{h^2}{2} + (1-2\,\varepsilon R+\delta R^2)\frac{h^3}{3} + (\varepsilon-2\,\delta R)\frac{h^4}{4} + \delta\frac{h^5}{5}\right).$$

Kaldes Jordens midlere Tæthed D, dens Masse M, og er k en Constant, g_o Tyngden i Havoverfladen, g_h Tyngden i Dybden h, saa har man

[1] O. J. Broch. Accéleration de la pesanteur etc. Mémoires et travaux du bureau international des poids et mesures.

extent of such a surface, and thus have no influence whatever on the tendency of the water to rise or sink.

7. Pressure in the Deep.

An atmosphere is the pressure exerted by a column of mercury of a temperature of 0° and a height of 0.76 metre, at sea-level and latitude 45° (standard gravity).

Now, the specific gravity of mercury, referred to pure water of 4° C, being, at 0°, 13.5959, and an English fathom being equal to 1.82876694 metre, the specific gravity of sea-water, referred to pure water of 4° C. (its density) being S, the pressure of 1 fathom of sea-water =

$$\frac{1.82876694}{13.5959} \cdot \frac{S}{0.76} = 0.1769851\ S \text{ atmospheres}$$

at sea-level and latitude 45°.

The factor 0.1769851 I call a_o; $\log a_o = 9.2479368-10$.

$$\text{Inverted, 1 atmosphere} = 1^{at} = \frac{1}{a_o S} = \frac{5.6502}{S}$$

fathoms' pressure.

The pressure of one fathom of sea-water is proportionate to the force of gravity. This varies with the latitude and with the depth below the sea-surface. The variation of the force of gravity with latitude, is expressed, according to Broch,[1] by the formula

$$g_\varphi = g_{45}\,(1-\beta\cos 2\,\varphi), \text{ in which } \beta = 0.00259,$$

g_φ being the gravity at sea-level and latitude φ, g_{45} the gravity at sea-level and latitude 45° (standard gravity).

The variation of the force of gravity with the depth in the sea, I have computed in the following manner.

By reason of the compressibility of sea-water, its density will increase with depth, i. e. with pressure. Now, calling the depth below the sea-surface h, the density of the sea-water at the surface d_o, and with ε and δ as constants, we can put the density in the depth h

$$d_h = d_o\,(1+\varepsilon h+\delta h^2)$$

And, calling the radius of the earth R, we get the mass of a water-stratum with radius $R-h$, thickness dh, and density d_h

Integrating this expression between the limits $h=0$ and $h=h$, we get for the mass of the water-stratum, from the surface of the sea to the depth h,

Now, let D be the mean density of the earth, M its mass, and k a constant, g_o the gravity at the surface of the sea, g_h the gravity at the depth h, then we have

[1] O. J. Broch. Accéleration de la pesanteur etc. Mémoires et travaux du bureau international des poids et mesures.

$$M = \tfrac{4}{3}\,\pi\,R^3\,D.$$

$$g_h = k\,\frac{M-m}{(R-h)^2} = \tfrac{4}{3}\,\frac{\pi\,k}{(R-h)^2}\left(R^3\,D - 3\,d_o\left[R^2\,h + R\,(\varepsilon\,R-2)\,\frac{h^2}{2} + (1-2\,\varepsilon\,R + \delta\,R^2)\,\frac{h^3}{3} + (\varepsilon - 2\,\delta\,R)\,\frac{h^4}{4} + \delta\,\frac{h^5}{5}\right]\right)$$

$$g_o = k.\,\frac{M}{R^2} \qquad = \tfrac{4}{3}\,\pi\,k\,R\,D$$

og efter nogle Reductioner

and after a few reductions

$$\frac{g_h}{g_o} = 1 + \left(2 - 3\,\frac{d_o}{D}\right)\frac{h}{R} + \left(3 - \frac{d_o}{D}\,(3 + \tfrac{3}{2}\,\varepsilon\,R)\right)\frac{h^2}{R^2} + \left(4 - \frac{d_o}{D}\,(4 - \varepsilon\,R + \delta\,R^2)\right)\frac{h^3}{R^3} + \ldots\ldots$$

eller for Kortheds Skyld

or, for the sake of brevity,

$$g_h = g_o\,(1 + b.\,h + c.\,h^2 + e.\,h^3),\ \text{hvor } (\textit{in which})\ b = \frac{1}{R}\left(2 - 3\,\frac{d_o}{D}\right)$$

$$c = \frac{1}{R^2}\left(3 - \frac{d_o}{D}\,(3 + \tfrac{3}{2}\,\varepsilon\,\mathrm{R})\right)$$

$$e = \frac{1}{R^3}\left(4 - \frac{d_o}{D}\,(4 - \varepsilon\,R + \delta\,R^2)\right)$$

Coefficienten e bliver i ethvert Tilfælde forsvindende liden, da den er omvendt proportional med 3die Potents af R.

Efter en Beregning, som nedenfor er nærmere begrundet, kan man sætte $d_o = 1.027591$ og $\varepsilon = 0.0000085248$. Sætter man $D = 5.6$ og R (70° Bredde) $= 3476982$ eng. Favne, faar man

$b = \quad 0.00000041698 \qquad \log b = 3.62002 - 10$

$c = -\,0.0000000000004722\ \log c = 7.67413 - 20$

Ogsaa Coefficienten c bliver forsvindende liden.

Tyngdens Forandring med Dybden er ogsaa afhængig af Centrifugalkraftens Aftagen med Tilnærmelsen til Jordens Centrum. Centrifugalkraftens Component langs Verticallinien er

$$c' = \frac{4\,\pi^2\,R}{T^2}\cos^2\varphi,$$

hvor T = Jordens Omdrejningstid = Stjernedagen = 86164 Secunder Middeltid. Heraf faar man

$$dc' = \frac{4\,\pi^2}{T^2}\cos^2\varphi\,d\,R = \frac{4\,\pi^2}{T^2}\cos^2\varphi.\ h,$$

altsaa Tyngden i Dybden h

$$g_h = g_o + \frac{4\,\pi^2}{T^2}\cos^2\varphi.\ h = g_o\left(1 + \frac{4\,\pi^2\cos^2\varphi}{g_o\,T^2}\,h\right)$$

Udfører man Beregningen for 70° Bredde, hvor g_o er lig 9.8256, saa faar man

$$g_h = g_o\,(1 + 0.0000000000633.\ h).$$

Centrifugalkraftens Virkning bliver altsaa forsvindende.

Jeg sætter saaledes som Udtryk for Tyngdens Tilvæxt med Dybet[1]

$g_h = g_o\,(1 + b.\,h)$, hvor $\log b = 3.62002 - 10$.

Som man ser, forudsætter denne Formel, at Jorden overalt er dækket med Hav. Der er intet Hensyn taget til Continenternes Tiltrækning. Formelens Constant ligger mellem Værdierne for Luften og for Continent. Den vil

The coefficient e will in any case prove insensible, being inversely as the third power of R.

According to a computation I have set forth more in detail below, we can put $d_o = 1.027591$ and $\varepsilon = 0.0000085248$. Now, putting $D = 5.6$ and R (lat. 70°) $= 3476982$ Eng. fathoms, we get

$b = \quad 0.00000041698 \qquad \log b = 3.62002 - 10$

$c = -\,0.0000000000004722\ \log c = 7.67413 - 20.$

The coefficient c is also well-nigh insensibly small.

The variation of gravity with depth likewise depends on the diminution of centrifugal force on approaching the centre of the earth. The component of the centrifugal force along the vertical line is

$$c' = \frac{4\,\pi^2\,R}{T^2}\cos^2\varphi.$$

in which T = the time of the earth's rotation = the sidereal day = 86164 seconds of mean time. This gives

$$dc' = \frac{4\,\pi^2}{T^2}\cos^2\varphi\,d\,R = \frac{4\,\pi^2}{T^2}\cos^2\varphi.\ h.$$

Hence the gravity at the depth h,

$$g_h = g_o + \frac{4\,\pi^2}{T^2}\cos^2\varphi.\ h = g_o\left(1 + \frac{4\,\pi^2\cos^2\varphi}{g_o\,T^2}\,h\right).$$

Computing g_h for lat. 70° N. in which $g_o = 9.8256$, we get

$$g_h = g_o\,(1 + 0.0000000000633.\ h)$$

The effect of centrifugal force is accordingly insensible.

Hence, I take as the expression for increase of gravity with depth[1]

$g_h = g_o\,(1 + b.\,h)$, in which $\log b = 3.62002 - 10$.

As will appear, this formula assumes the earth to be everywhere covered with water. No regard has been paid to the attraction of the continents. The constant of the formula lies between the values for atmospheric

[1] Sættes med Weihrauch (Ueber die dynamischen Centra des Rotationsellipsoids) $R = 3482000$ eng. Fv. (70° Br.) og med v. Jolly $D = 5.69$, faar man $\log b = 3.6220$. Med $D = 5.62$ faar man $\log b = 3.6200$. Disse Differentser have ingen praktisk Betydning.

[1] Putting, with Weihrauch (Ueber die dynamischen Centra des Rotationsellipsoids), $R = 3482000$ fathoms (Lat. 70°) and, with v. Jolly, $D = 5.69$, we get $\log b = 3.6220$. With $D = 5.62$, we get $\log b = 3.6200$. The differences have no practical significance.

være rigtigst for de midterste og dybeste Dele af Havet. Henimod Kysterne vil den være mindre rigtig, men her blive Dybderne mindre og Tyngdens Tilvæxt selv mere og mere forsvindende.

Tyngdens Tilvæxt med Tilnærmelsen til Jordens Centrum beregnes saaledes

For Atmosfæren $g_h = g_o \left(1 + 2\frac{h}{R}\right)$

„ Havet $g_h = g_o \left(1 + 1.45\frac{h}{R}\right)$

„ Continent $g_h = g_o \left(1 + 1.25\frac{h}{R}\right)$.

Angaaende den Nøjagtighed, hvormed Factoren b er fundet, kan anstilles følgende Beregninger. Vi have

$$b = \frac{1}{R}\left(2 - 3\frac{d_o}{D}\right),$$

altsaa $d\,b = -\,b.\frac{d\,R}{R} - 3\frac{d\,d_o}{R\,D} + 3\frac{d_o\,d\,D}{R\,D^2}$.

Sættes $d\,R = \pm\,500$ Meter (den halve Forskjel mellem Clarke's og Listings Jordradius), $d\,d_o = \pm\,0.00005$ og $d\,D = \pm\,0.1$, saa faar man med de til Beregningen af b brugte Constanter

$$d\,b = \pm\,0.000\,000\,002\,829.$$

Vi faa saaledes følgende Udtryk for Tyngdens Størrelse i Bredden φ og Dybden h

$$g_{\varphi h} = g_{45}\,(1 - \beta\cos 2\,\varphi)\,(1 + b.\,h).$$

Havvandets Tæthed i Dybet er større end i Overfladen, da Vandet sammentrykkes noget af Vægten af de overliggende Vandlag. Er Trykket i et Punkt i Dybet p Atmosfærer og Søvandets Sammentrykkelighedscoefficient for en Atmosfære μ, saa er, naar dets Tæthed under almindeligt Lufttryk, 1 Atmosfære, er S_o (tidligere betegnet som $S^{t^o}_{4^o}$), dets Tæthed S_p under Trykket p

$$\frac{S_o}{1 - \mu\,p}.$$

Det rene Vands Sammentrykkelighedscoefficient er afhængig af Temperaturen og af Trykket. Herom henvises til IV Del af denne Afhandling "Om Piezometret som Dybdemaaler og Vandets Sammentrykkelighed". Antager man, at Søvandet følger de samme Love for Sammentrykning, kan man sætte μ under Formen

$$\mu = (\mu_o - 0.159\,t - 0.000314\,t^2)\,(1 - 0.00009325\,p),$$

hvor t er Vandets Temperatur, p Vandtrykket i Atmosfærer og μ_o Coefficienten ved 0^0 og almindeligt Lufttryk.

Regnault[1] fandt Sammentrykkelighedscoefficienten for Søvand af en Temperatur af 17^0.5 og specifisk Vægt 1.0264

[1] Moussons Physik, I, S. 253.

and for continental attraction. It will prove most accurate for the middle and the deepest parts of the sea. On approaching the coast, it will be less accurate; but there the depths are less, and consequently the increase of gravity itself becomes more and more insensible.

The increase of gravity with the approach to the centre of the earth is accordingly computed as follows: —

For the Atmosphere $g_h = g_o \left(1 + 2\frac{h}{R}\right)$

„ „ Ocean $g_h = g_o \left(1 + 1.45\frac{h}{R}\right)$

„ „ Continent $g_h = g_o \left(1 + 1.25\frac{h}{R}\right)$.

Concerning the precision with which the factor b has been found, the following computations can be made. We have

$$b = \frac{1}{R}\left(2 - 3\frac{d_o}{D}\right);$$

hence $d\,b = -\,b.\frac{d\,R}{R} - 3\frac{d\,d_o}{RD} + 3\frac{d_o\,d\,D}{R\,D^2}$.

Putting $d\,R = \pm\,500$ metres (half the difference between Clarke's and Listing's values of the earth's radius), $d\,d_o = \pm\,0.00005$, and $d\,D = \pm\,0.1$, we get, with the constants made use of for calculating b,

$$d\,b = \pm\,0.000\,000\,002\,829.$$

Thus we have the following expression for the force of gravity in latitude φ and depth h

$$g_{\varphi h} = g_{45}\,(1 - \beta\cos 2\,\varphi)\,(1 + b.\,h).$$

The density of sea-water in the deep is greater than at the surface, the water being compressed to some extent by the weight of the superincumbent strata. Assuming the pressure at a given point in the deep to be p atmospheres, and the coefficient of compression of sea-water for one atmosphere to be μ, then, provided its density under ordinary atmospheric pressure, 1 atmosphere, be S_o (previously denoted by $S^{t^o}_{4^o}$), its density, S_p, under the pressure p, is

$$\frac{S_o}{1 - \mu\,p}.$$

The coefficient of compression of pure water depends on temperature and on pressure. As to this subject, the reader is referred to Part IV of the present Memoir, viz., "The Piezometer as a Depth-Meter and the Compressibility of Water." Now, assuming sea-water subject to the same laws regarding compression, we can put

$$\mu = (\mu_o - 0.159\,t - 0.000314\,t^2)\,(1 - 0.00009325\,p),$$

in which t is the temperature of the water, p the water-pressure in atmospheres, and μ_o the coefficient at 0^0 and ordinary atmospheric pressure.

Regnault[1] found the coefficient of compression for sea-water with a temperature of 17^0.5 and a specific

[1] Moussons Physik, I, p. 253.

at være 43.6 Milliontedele. Herefter faar man

$$\eta_0 = (43.6 + 2.7825 + 0.0962)\ 10^{-6} = 46.4787 \times 10^{-6}.$$

J. Y. Buchanan, Challenger-Expeditionens Chemiker, har fundet, at Søvandets Coefficient er 92.3 Procent af det rene Vands. Da dette kan sættes[1] til 50.153×10^{-6} ved 0^0 og almindeligt Lufttryk, faaes heraf $\eta_0 = 50.153 \times 0.923 \times 10^{-6} = 46.291 \times 10^{-6}$.

Tait[2] har fundet den samme Procent at være 92.5, hvoraf $\eta_0 = 46.392 \times 10^{-6}$.

Middel af disse Bestemmelser er 46.387×10^{-6}.

Den følgende lille Tabel giver en Oversigt over Størrelsen af Factoren η i Formelen for p paa næste Side i Milliontedele, ved forskjellige forekommende Temperaturer og Tryk.

gravity of 1.0264, to be 43.6 millionths. According to this result we get

$$\eta_0 = (43.6 + 2.7825 + 0.0962)\ 10^{-6} = 46.4787 \times 10^{-6}.$$

Mr. J. Y. Buchanan, Chemist to the Challenger Expedition, found the coefficient of sea-water to be 92.3 per cent compared to that for pure. Now as this may be put[1] $= 50.153 \times 10^{-6}$ at 0^0 and ordinary atmospheric pressure, we get $\eta_0 = 50.153 \times 0.923 \times 10^{-6} = 46.291 \times 10^{-6}$.

Tait[2] has found the same percentage to be 92.5, whence $\eta_0 = 46.392 \times 10^{-6}$.

The mean of these determinations is 46.387×10^{-6}.

The following short Table will give a general view of the value of the factor η in the formula for p, next page, in millionths, at different actual temperatures and pressures.

Dybde i Favne. (Depth in Fathoms.)	t	p	η
0	5°.0	0 at	45.58
0	0 .0	0	46.39
416	2 .0	75.968	45.74
1333	—0 .7	244.482	45.43
1985	—1 .7	365.008	45.03

η vil saaledes falde mellem 45 og 46 Milliontedele. I mine Beregninger har jeg antaget η constant lig 45×10^{-6}.

Den heraf flydende Fejl har, som senere skal vises, ingen stor Indflydelse paa det beregnede Tryk, end mindre paa Tryk-Forskjeller i samme Dybde-Niveau.

Er i Dybden h Favne Trykket af det overliggende Vand p Atmosfærer, og er Søvandets Tæthed, ved almindeligt Lufttryk, S_0, saa er dets Tæthed, i Dybden h, $\frac{S_0}{1-\eta p}$. Det Tryk, dp, som en vertical Vandsøjle af Højden dh udøver ved sin Gravitation, er proportionalt med Tyngdens Størrelse. Man faar saaledes

Thus η will vary between 45 and 46 millionths. In my computations, I have regarded η as constant, and equal to 45×10^{-6}.

The errors arising therefrom have, as will subsequently be shown, no considerable influence on the computed pressure, and far less on differences of pressure throughout the same level.

If, at the depth h fathoms, the pressure of the superincumbent water is p atmospheres, and if the density of the sea-water at ordinary atmospheric pressure is S_0, then its density at the depth h will be $\frac{S_0}{1-\eta p}$. The pressure, dp, which a vertical column of water of the height dh exerts by its gravitation, is proportional to the force of gravity. Hence we get

$$dp = a_0 \frac{S_0}{1-\eta p}\, dh\, \frac{g_{\varphi h}}{g_{45}} = a_0 \frac{S_0}{1-\eta p} (1 - \beta \cos 2\varphi)\ (1 + b.h)\ dh.$$

For at kunne integrere denne Ligning maatte man kjende den Lov, hvorefter Tætheden S_0 varierer med Dybden. Som Snittene Pl. XXXIX til XLI vise, er denne forskjellig i de forskjellige Verticallinier. Forskjellerne ere imidlertid ikke store, og saavel numeriske Beregninger som theoretiske Betragtninger, hvis Resultat senerehen skal meddeles, vise, at man kommer til den ønskede Nøjagtighed, om man regner med en constant Værdi af Vandets Tæthed og sætter denne lig Middeltallet af Tæthederne i de

In order to integrate this equation, it is necessary to know the law according to which the density S_0 varies with the depth. As shown by the sections Pl. XXXIX to Pl. XLI, this differs along the different vertical lines. The differences however are not considerable, and alike numerical computations and theoretical considerations, the result of which will be subsequently given, clearly prove that the desired accuracy is reached, if we calculate with a constant value for the density of the water and put the latter

[1] Travaux et mémoires du bureau international des poids et mesures, Tome II, D. 30.

[2] Proceedings of the Royal Society Edinburgh. 1883. S. 224.

[1] Travaux et mémoires du bureau international des poids et mesures, Tome II. D. 30.

[2] Proceedings of the Royal Society Edinburgh, 1883, p. 224.

overliggende Vandlag. Kaldes dette Middeltal Σ, kan man altsaa sætte

$$d\,p = \frac{a_o\,\Sigma\,(1 - \beta \cos 2\,\varphi)\;(1 + b.\,h)}{1 - \eta\,p}\,d\,h.$$

Integreres denne Ligning mellem Grændserne $h = 0$ og $h = h$, faar man, da Vandtrykket er 0, naar h er lig 0,

$$p = \frac{a_o\,\Sigma\,(1 - \beta \cos 2\,\varphi)\;(1 + \tfrac{1}{2}\,b.\,h)}{1 - \tfrac{1}{2}\,\eta\,p}\,h.$$

Denne Ligning løses lettest ved successiv Approximation. Den første tilnærmede Værdi giver Tælleren (p_1). Denne indsat i Nævneren, giver den anden Tilnærmelse (p), og denne atter indsat i Nævneren fører ved den tredie Regning til Resultat.

equal to the mean of the densities in the superincumbent strata. If this mean be called Σ, we can accordingly put

$$d\,p = \frac{a_o\,\Sigma\,(1 - \beta \cos 2\,\varphi)\;(1 + b.\,h)}{1 - \eta\,p}\,d\,h.$$

Now, with this equation integrated between the limits $h = 0$ and $h = h$, we get, the water-pressure being nil, when $h = 0$.

$$p = \frac{a_o\,\Sigma\,(1 - \beta \cos 2\,\varphi)\;(1 + \tfrac{1}{2}\,b.\,h)}{1 - \tfrac{1}{2}\,\eta\,p}\,h.$$

The present equation is most easily solved by successive approximation. The first approximative value the numerator will furnish (p_1). This, substituted into the denominator, gives the second approximation (p_2), and this substituted into the denominator leads by the third computation to the result.

Exempel (*Example*). $\Sigma = 1.0278403$; $h = 1500$ Favne (*fathoms*); $\varphi = 45^0$; $\beta \cos 2\,\varphi = 0$.

$$\begin{array}{ll}
\text{Log } \tfrac{1}{2}\,h & = 2.87506 \\
\text{Log } b & = 3.62002 - 10 \\
\text{Log } \tfrac{1}{2}\,b\,h & = 6.49508 - 10 \\
\tfrac{1}{2}\,b\,h & = 0.0003127 \\
1 + \tfrac{1}{2}\,b\,h & = 1.0003127
\end{array}
\qquad
\begin{array}{ll}
\text{Log } (1 + \tfrac{1}{2}\,b\,h) & = 0.00013578 \\
\text{Log } h & = 3.1760913 \\
\text{Log } a_o & = 9.2479368 - 10 \\
\text{Log } \Sigma_o & = 0.01192566 \\
\hline
\text{Log } p_1 & = 2.43608954
\end{array}
\qquad
\begin{array}{ll}
\text{Log } p_1 & = 2.43609 \\
\text{Log } \tfrac{1}{2} & = 9.69897 - 10 \\
\text{Log } \eta & = 5.65321 - 10 \\
\hline
\text{Log } \tfrac{1}{2}\,\eta\,p_1 & = 7.78827 - 10 \\
\tfrac{1}{2}\,\eta\,p_1 & = 0.006141 \\
1 - \tfrac{1}{2}\,\eta\,p_1 & = 0.993859
\end{array}$$

$$\begin{array}{ll}
\text{Log } p_1 & = 2.4360895 \\
\text{Log } (1 - \tfrac{1}{2}\,\eta\,p_1) & = 9.9973248 - 10 \\
\text{Log } p_2 & = 2.4387647 \\
\text{Log } \tfrac{1}{2}\,\eta & = 5.35218 - 10 \\
\hline
\text{Log } \tfrac{1}{2}\,\eta\,p_2 & = 7.79094 - 10 \\
\tfrac{1}{2}\,\eta\,p_2 & = 0.006179 \\
1 - \tfrac{1}{2}\,\eta\,p_2 & = 0.993821
\end{array}
\qquad
\begin{array}{ll}
\text{Log } p_1 & = 2.4360895 \\
\text{Log } (1 - \tfrac{1}{2}\,\eta\,p_2) & = 9.9973081 - 10 \\
\text{Log } p_3 & = 2.4387814 \\
\text{Log } \tfrac{1}{2}\,\eta & = 5.35218 - 10 \\
\hline
\text{Log } \tfrac{1}{2}\,\eta\,p_3 & = 7.79096 - 10 \\
\tfrac{1}{2}\,\eta\,p_3 & = 0.0061796 \\
1 - \tfrac{1}{2}\,\eta\,p_3 & = 0.9938204
\end{array}
\qquad
\begin{array}{ll}
\text{Log } p_1 & = 2.4360895 \\
\text{Log } (1 - \tfrac{1}{2}\,\eta\,p_3) & = 9.9973079 - 10 \\
\hline
\text{Log } p & = 2.4387816 \\
p & = 274.6513
\end{array}$$

Antager man, at Vandets Tæthed (under almindeligt Luftryk) voxer jevnt med Dybden, saa at man kan sætte

$$S_o = S\,(1 + \gamma\,h),$$

hvor γ er en Constant og S Tætheden i Overfladen, saa har man, naar Bredden sættes lig 45^0,

Assuming the density of water (under ordinary atmospheric pressure) to increase uniformly with the depth, so that we can put

$$S_o = S\,(1 + \gamma\,h),$$

in which γ is a constant and S the density at the surface, we have, putting the latitude equal to 45^0,

$$d\,p = \frac{a_o\,S\,(1 + \gamma\,h)\;(1 + b\,h)}{1 - \eta\,p}\,d\,h,$$

$$p = a_o\,S\,\frac{(1 + \tfrac{1}{2}\,\gamma\,h + \tfrac{1}{2}\,b\,h + \tfrac{1}{3}\,\gamma\,b\,h^2)\,h}{1 - \tfrac{1}{2}\,\eta\,p} = \frac{a_o\,S\,((1 + \tfrac{1}{2}\,\gamma\,h)\,(1 + \tfrac{1}{2}\,b\,h) + \tfrac{1}{12}\,\gamma\,b\,h^2)\,h}{1 - \tfrac{1}{2}\,\eta\,p}.$$

Her er $\Sigma = S\,(1 + \tfrac{1}{2}\,\gamma\,h)$ og Forskjellen mellem Beregningen med Σ og med γ bliver

$$\tfrac{1}{12}\,\frac{a_o\,S\,\gamma\,b\,h^3}{1 - \tfrac{1}{2}\,\eta\,p}.$$

Sætter man $S = 1.0273$ og regner med dens sterkeste Tilvæxt med Dybden, der er 0.00028 pr. 100 Favne, har man

$$S\,\gamma\,h = 1.0273 \times \gamma \times 100 = 0.00028$$
$$\gamma = 0.000002726.$$

Fejlen voxer med Dybden. Beregne vi den for 2000 Favnes Dyb, hvor $p = 367$ Atmosfærer, faa vi Fejlen lig

Here $\Sigma = S\,(1 + \tfrac{1}{2}\,\gamma\,h)$, and the difference between the computation with Σ and with γ is

$$\tfrac{1}{12}\,\frac{a_o\,S\,\gamma\,b\,h^3}{1 - \tfrac{1}{2}\,\eta\,p}.$$

Putting $S = 1.0273$ and calculating with the greatest existing increase with the depth, viz., 0.00028 per 100 fathoms, we have

$$S\,\gamma\,h = 1.0273 \times \gamma \times 100 = 0.00028,$$
$$\gamma = 0.000002726.$$

The error increases with the depth. Computing for a depth of 2000 fathoms, at which $p = 367$ atmospheres,

0.000139 Atmosfære eller 0.106 mm Kviksølvtryk. En saa sterk Tilvæxt eller Aftagen med Dybden som den, vi have regnet med, forekommer ikke i de større Dyb. Man kan saaledes trygt regne med constant Σ.

Ved Studiet af Vandets Bevægelse i Havets Dyb gjælder det at kjende Trykket i forskjellige Punkter af samme Niveauflade. Havets Overflade vilde være en Niveauflade, naar det var i Hvile og der paa hvert Punkt af Overfladen var samme absolute Lufttryk. Den vilde da staa lodret paa Tyngdens Retning i ethvert Punkt, men Tyngdens Størrelse vilde aftage fra Polerne mod Æquator. Igjennem hvert Punkt i Havet kan lægges en Niveauflade, der er characteriseret derved, at der paa alle dens Punkter hviler samme Tryk. I Forbindelse hermed staar, at Afstanden mellem to paa hinanden følgende Niveauflader, maalt langs Verticallinien, er omvendt proportional med Tyngdens Størrelse.

Antages Lufttrykket constant, Havvandets Tæthed lig Σ, er $p_{\varphi h}$ Vandtrykket i Bredden φ og Dybden h, og $p_{45\,H}$ Vandtrykket i 45° Bredde og Dybden H, saa er

the error will equal 0.000139 atmosphere, or 0.106 mm. mercury-pressure. So considerable an increase or diminution with depth as that we have assumed, does not occur at great depths. Hence, we can safely compute with Σ as constant.

For investigating the motion of the water in the depths of the ocean, we must know the pressure at the various points of the same surface of level. The surface of the sea would be a surface of level were it at rest, and were each of the points of the surface subjected to the same absolute atmospheric pressure. It would then stand perpendicular to the direction of gravity at every point; but the force of gravity would diminish from the poles to the equator. Through every point of the sea can be laid a surface of level, characterized by its having the same pressure at all of its points. In connexion herewith we have the corollary, that the distance between two consecutive surfaces of level, measured along the vertical line, is inversely as the force of gravity.

Assuming the atmospheric pressure constant, the density of the sea-water equal to Σ, the water-pressure $p_{\varphi h}$ in the latitude φ and at the depth h, and the water-pressure $p_{45\,H}$ on the 45th parallel of latitude and at the depth H, then

$$p_{\varphi h} = \frac{a_o \,\Sigma (1 - \beta \cos 2\varphi)(1 + \frac{1}{2} b.\, h)}{1 - \frac{1}{2} \eta\, p_{\varphi h}}\, h$$

$$p_{45\,H} = \frac{a_o \,\Sigma (1 + \frac{1}{2} b.\, H)}{1 - \frac{1}{2} \eta\, p_{45\,H}}\, H$$

Skulle begge disse Punkter tilhøre samme Niveauflade, maa $p_{\varphi h} = p_{45\,H}$ eller

$$(1 - \beta \cos 2\varphi)\,(1 + \tfrac{1}{2} b.\, h)\, h = (1 + \tfrac{1}{2} b.\, H)\, H$$

$$h = \frac{H}{1 - \beta \cos 2\varphi} \cdot \frac{1 + \frac{1}{2} b\, H}{1 + \frac{1}{2} b\, h}$$

Da den midlere Tyngde i Bredden φ ($g_{m\varphi}$) er lig $g_{45}\,(1 - \beta \cos 2\varphi)\,(1 + \frac{1}{2} b\, h)$ og i 45° Bredde ($g_{m\,45}$) lig $g_{45}(1 + \frac{1}{2} b\, H)$, har man $\frac{h}{H} = \frac{g_{m\,45}}{g_{m\varphi}}$ eller Niveaufladens Afstand fra Overfladens Niveauflade omvendt proportional med Tyngden. Da b er en meget liden Størrelse, kan man sætte

If both of these points are to belong to the same surface of level, we must have $p_{\varphi h} = p_{45\,H}$, or

$$(1 - \beta \cos 2\varphi)\,(1 + \tfrac{1}{2} b\, h)\, h = (1 + \tfrac{1}{2} b\, H)\, H.$$

$$h = \frac{H}{1 - \beta \cos 2\varphi} \cdot \frac{1 + \frac{1}{2} b\, H}{1 + \frac{1}{2} b\, h}.$$

The mean gravity in latitude φ ($g_{m\varphi}$) being equal to $g_{45}\,(1 - \beta \cos 2\varphi)\,(1 + \frac{1}{2} b\, h)$, and in latitude 45° ($g_{m\,45}$) equal to $g_{45}\,(1 + \frac{1}{2} b\, H)$, we get $\frac{h}{H} = \frac{g_{m\,45}}{g_{m\varphi}}$, or the distance of the surface of level in the deep from that of the surface of the sea, inversely as the force of gravity. Since b is but a small quantity, we can put

$$\frac{1 + \frac{1}{2} b\, H}{1 + \frac{1}{2} b.\, h} = 1 + \tfrac{1}{2} b\, H - \tfrac{1}{2} b\, h - \tfrac{1}{4} b^2\, h\, H + \tfrac{1}{4} b^2\, h^2 + \tfrac{1}{8} b^3\, h^2\, H + \ldots\ldots = 1 + \tfrac{1}{2} b\,(H - h),$$

idet man udelader Leddene med de højere Potenser af b. Indsætter man her den tilnærmede Værdi af $h = \frac{H}{1 - \beta \cos 2\varphi}$, faar man

excluding all terms with the higher powers of b. Now, if we substitute here the approximate value of $h = \frac{H}{1 - \beta \cos 2\varphi}$, we get

$$h = \frac{H}{1 - \beta \cos 2\varphi} \left(1 + \tfrac{1}{2} b \left(H - \frac{H}{1 - \beta \cos 2\varphi}\right)\right) = \frac{H}{1 - \beta \cos 2\varphi} + \tfrac{1}{2} b.\, \frac{H^2\, \beta \cos 2\varphi}{(1 - \beta \cos 2\varphi)^2}.$$

For det extreme Tilfælde $\varphi = 80°$, $H = 2000$ Favne, bliver det sidste Led $= 0.00202$ Favne, der svarer til

In the extreme case that $\varphi = 80°$, $H = 2000$ fathoms, the last term will $= 0.00202$ fathoms, which corresponds

0.28 mm Kviksølvtryk. Man kan altsaa sætte

$$h = \frac{H}{1 - \beta \cos 2\varphi}$$

hvor h betegner Dybden — regnet fra Overfladens Niveauflade — i Bredden φ, af den Niveauflade, der under 45° Bredde ligger i Dybden H. Da Nævneren i Udtrykket for h er større end 1 for højere Bredder end 45°, bliver samme Niveauflades Dybde mindre, jo større Bredden bliver. Den følgende Tabel giver en Oversigt over forskjellige Niveaufladers Dybde under forskjellige Breddegrader.

to a mercury-pressure of 0.28 mm. Accordingly we can put

$$h = \frac{H}{1 - \beta \cos 2\varphi},$$

in which formula h denotes the depth — reckoned from the level of the surface — in the latitude φ, of the surface of level, which in latitude 45° lies at the depth H. As the denominator in the expression for h is greater than 1 for higher latitudes than 45°, the depth of one and the same surface of level will be less the higher the latitude. The following Table gives a general view of the depths of the different surfaces of level on different parallels of latitude.

Bredde (*Lat.*) 45°	60°		70°		80°	
H	h	H-h	h	H-h	h	H-h
100 Fv.	99.87	0.13	99.80	0.20	99.76	0.24
500	499.35	0.65	499.01	0.99	498.78	1.22
1000	998.71	1.29	998.02	1.98	997.57	2.43
1500	1498.06	1.94	1497.03	2.97	1496.35	3.65
2000	1997.41	2.59	1996.03	3.97	1995.14	4.86

Niveaufladen betegnes ved Tilføjelse af Favnetallet for dens Dybde ved 45° Bredde. Niveaufladen H_{2000} ligger saaledes næsten 5 Favne højere, nærmere Overfladen, under 80° Bredde end under 45°. Differentsen, 4.86 Favne, svarer til en Trykforskjel af 4.86 $a_o\, S$ eller 0.8838 Atmosfære. Man ser, hvor nødvendigt det er at tage Hensyn til Niveaufladernes forskjellige Dybde ved Beregningen af Vandtrykket i Dybet.

The surface of level is indicated by annexing the number of fathoms expressing its depth on the 45th parallel of latitude. The surface of level H_{2000} lies therefore almost 5 fathoms higher, viz., nearer the surface, on the 80th parallel of latitude than it does on the 45th parallel. The difference, 4.86 fathoms, corresponds to a difference of pressure of 4.86 $a_o\, S$, or 0.8838 atmosphere. Hence we see how necessary it is to pay regard to the varying depth of the surfaces of level when computing the pressure of the water in the depths of the ocean.

I Niveaufladen, der under 45° Bredde ligger i Dybden H, har man altsaa

In the surface of level lying, on the 45th parallel of latitude, at the depth H, we have accordingly: —

$$p = \frac{a_o\, \Sigma (1 - \beta \cos 2\varphi)(1 + \frac{1}{2} b.h)}{1 - \frac{1}{2}\eta p} \cdot \frac{H}{1 - \beta \cos 2\varphi} \cdot \frac{1 + \frac{1}{2} b.H}{1 + \frac{1}{2} b.h}$$

$$\text{eller } (or) \quad p = \frac{a_o\, \Sigma (1 + \frac{1}{2} b.H)}{1 - \frac{1}{2}\eta p} \cdot H \cdot$$

Formelen bliver saaledes simplificeret. Tyngdens Variation med Bredden falder bort, og man regner med den Dybde ved 45°, der characteriserer Niveaufladen.

The formula is thus simplified. No account need be taken of the variation of the force of gravity with latitude; and we compute with the depth on the 45th parallel, which characterizes the surface of level.

For at undersøge den Indflydelse, Unøjagtigheden i de anvendte Størrelser har paa Resultatet, differentieres Udtrykket for p med Hensyn til Σ, b og η. Man faar da

With a view to investigate the effect which the errors in the applied quantities have on the final result, the expression for p is differentiated with respect to Σ, b, and η. We then get

$$d\,p = \frac{a_o (1 + \frac{1}{2} b.H) H}{1 - \eta p} d\,\Sigma + \frac{\frac{1}{2} a_o\, \Sigma H^2}{1 - \eta p} d\,b + \frac{\frac{1}{2} p^2}{1 - \eta p} d\,\eta.$$

Den midlere Fejl af en Bestemmelse af den specifiske Vægt, som Middeltal af Aræometeraflæsning og Chlorbestemmelse, er ifølge Tornøe[1] 0.000069. Den sandsynlige Fejl af en saadan bliver altsaa 0.000049, et Tal, der ogsaa be-

The mean error of a determination of specific gravity taken as the mean of an areometer-reading and a chlorine-determination, is, according to Tornøe,[1] 0.000069. The probable error of such a determination will accordingly be

[1] H. Tornøe. Chemi, S. 65.

[1] H. Tornøe. Chemistry, p. 65.

tegner den sandsynlige Fejl af Beliggenheden af Linierne for ligestor specifisk Vægt i Snittene Pl. XXXVI til XXXVIII. I disse Tversnit ere Linierne trukne for en Differents af 0.0001. Af disse udtoges, i Tabellen S. 139—143, den gjennemsnitlige specifiske Vægt for Vandlagene paa 100 Favnes Mægtighed, hvilket kan ske med en Nøjagtighed af en halv Tiendedel af Liniernes Afstand. Den herved indførte midlere Fejl vil saaledes beløbe sig til $\pm$ 0.000005. Af Reductionstabellen Side 138 ser man, at i Nærheden af 0° er Differentsen i Reductionen for 0°.1 mindre end 0.000005, og da Dybtemperaturernes sandsynlige Fejl er mindre end $\pm$ 0°.05, indfører Reductionen i Tabellerne Side 139—143 fra specifisk Vægt til Tæthed, hvor Temperaturerne kun ere tagne i Tiendedels Grader, en mindre midlere Fejl end $\pm$ 0.000005. Jeg sætter saaledes den midlere Fejl af Tætheden i et Vandlag af 100 Favnes Mægtighed i Tabellerne Side 139—143 til

0.000049, an error that likewise indicates the probable error of the position of the lines for equal specific gravity in the sections Pl. XXXVI to Pl. XXXVIII. In these transverse sections the lines are drawn for a difference of 0.0001. From the said lines were extracted, (Table, p. 139 to 143) the average specific gravity for the strata of 100 fathoms, which admits of being done with a precision of half a tenth of the relative distance of the lines. The mean error thus introduced will accordingly amount to $\pm$ 0.000005. From the Table of Reduction, p. 138, it appears that near 0° the difference in reduction for 0°.1 is less than 0.000005; and the probable error of a deep-temperature being less than $\pm$ 0°.05, the reduction in the Tables, p. 139 to 143, from specific gravity to density, where the temperature has been taken only in tenths of degrees, introduces a mean error of less than $\pm$ 0.000005. Hence I put the mean error of density for a stratum of 100 fathoms (Tables, p. 139 to 143) at

$$\pm \sqrt{0.000069^2 + 0.000005^2 + 0.000005^2} = \pm 0.00006936.$$

og den sandsynlige Fejl til $\pm$ 0.000046 eller med rundt Tal

$$d\,S_o = \pm 0.00005.$$

Størrelsen Σ er bestemt ved at tage Middeltallet af Tallene for S_o i den sidste Rubrik i Tabellerne Side 139—143. Den sandsynlige Fejl af Σ for 500 Favnes Dyb eller $d\,\Sigma_{500}$ bliver saaledes lig $\pm \frac{d\,S_o}{\sqrt{5}}$; for Σ_{1000} bliver $d\,\Sigma$ lig $\pm \frac{d\,S_o}{\sqrt{10}}$, og for Σ_{1500} bliver $d\,\Sigma_o$ lig $\pm \frac{d\,S_o}{\sqrt{15}}$.

Ovenfor, Side 146, have vi fundet den sandsynlige Fejl af Factoren b

$$d\,b = \pm 0.000000002829.$$

Af den lille Tabel, Side 147, over Værdierne af Coefficienten η sees, at Forskjellen mellem den nøjagtig beregnede Værdi og den benyttede er for 500 Favnes Dyb 0.75×10^{-6}, for 1000 Favnes Dyb 0.5×10^{-6}, og for 1500 Favnes Dyb omtrent 0.3×10^{-6}. Disse Værdier anvender jeg for $d\eta$ i de Beregninger, hvis Resultat findes i den følgende Tabel. I denne er anført den højeste og den laveste Værdi af p og Σ, der forekomme i de tre Niveauer, endvidere Værdien af hvert af de tre Led efter Formelen for $d\,p$, beregnet med de ovenfor anførte Værdier for $d\,\Sigma$, $d\,b$ og $d\,\eta$, det sidste Led beregnet for hver af de extreme Værdier af p, og i sidste Rubrik Differentsen mellem Tallene i næstsidste Rubrik, alle disse Tal udtrykte i Millimeter Kviksølvhøjde (ved at multiplicere $d\,p$ med 760).

and the probable error at $\pm$ 0.000046, or, in round numbers,

$$d\,S_o = \pm 0.00005.$$

The value of Σ is determined by taking the mean of the figures for S_o in the last column of the Tables, p. 139 to 143. The probable error of Σ for a depth of 500 fathoms, or $d\,\Sigma_{500}$, will thus be equal to $\pm \frac{d\,S_o}{\sqrt{5}}$; for Σ_{1000}, $d\,\Sigma$ will be equal to $\pm \frac{d\,S_o}{\sqrt{10}}$, and for Σ_{1500}, $d\,S_o$ will be equal to $\pm \frac{d\,S_o}{\sqrt{15}}$.

Above, page 146, we found the probable error of the factor b

$$d\,b = \pm 0.000000002829.$$

From the short Table, page 147, giving the values of the coefficient η, it will appear that the difference between the accurately computed value and that made use of, amounts, for a depth of 500 fathoms, to 0.75×10^{-6}, for a depth of 1000 fathoms, to 0.5×10^{-6}, and for a depth of 1500 fathoms to close upon 0.3×10^{-6}. These values I have applied for $d\eta$, in the computations the result of which will be found in the following Table. This Table gives the highest and the lowest value of p and Σ that occurs in the three levels; next, the value of each of the three terms according to the formula for $d\,p$, computed with the values stated above for $d\,\Sigma$, $d\,b$, and $d\,\eta$, the last term being computed for each of the extreme values of p; and in the terminal column, the difference between the figures in the last column but one — all these figures expressed in millimetric height of mercury (multiplying $d\,p$ by 760).

H	p	Σ	$\left(\frac{dp}{d\Sigma}\right)d\Sigma$	$\left(\frac{dp}{db}\right)db$	$\left(\frac{dp}{d\eta}\right)d\eta$	Diff.
Favne. (*Fms.*)	Atm.		mm.	mm.	mm.	mm.
500	Max. 91.16	1.02796	1.51	0.05	2.37	0.01
	Min. 91.09	1.02716			2.38	
1000	Max. 182.78	1.02831	2.14	0.20	6.39	0.01
	Min. 182.61	1.02732			6.40	
1500	Max. 247.72	1.02809	2.64	0.45	8.69	0.01
	Min. 247.53	1.02741			8.70	

Heraf ser man, at de specifiske Vægter give Trykkene i Dybet med en Nøjagtighed af 2 til 3 Millimeter Kviksølvtryk. Usikkerheden i Tyngdefactoren b medfører ingen Usikkerhed i Trykkene, der gaar op til en halv Millimeter. En sandsynlig Tilstedeværelse af en Fejl i Coefficienten for Søvandets Sammentrykkelighed medfører en Fejl i Trykkene, der er ret merkelig. Men denne Fejl er saagodtsom constant over hele Havet i et og samme Niveau, saa at Trykforskjellerne i Niveaufladerne blive ganske uafhængige deraf. Dette sidste gjælder i end højere Grad Coefficienten b.

Fejlene i de beregnede Tryk-Forskjeller i Dybets Niveauflader blive saaledes praktisk talt kun afhængige af Fejlene i de beregnede Værdier af Σ. Forskjellen mellem Trykkene i to Punkter vil faa en sandsynlig Fejl af $\sqrt{2}\left(\frac{dp}{d\Sigma}\right)d\Sigma$, da Fejlene i hvert Punkt er $\pm\left(\frac{dp}{d\Sigma}\right)d\Sigma$. Disse sandsynlige Fejl blive altsaa:

i 500 Favnes Dyb $1.51\sqrt{2} = 2.14$ mm.
i 1000 — — $2.14\sqrt{2} = 3.03$
i 1500 — — $2.64\sqrt{2} = 3.73$

For at kunne bringe Nøjagtigheden op til 1 Millimeter Kviksølvtryk, maatte den specifiske Vægt bestemmes 4 Gange nøjagtigere, altsaa være nøjagtig i 5. Decimal, eller Antallet af Observationer af den specifiske Vægt være saa stort, at den sandsynlige Fejl af samme i et enkelt Punkt i Havets Dyb var 4 Gange mindre end den vi have opnaaet. Her tales kun om Dybder, der ikke synderlig overskride 1500 Favne.

Sammenlignes de sandsynlige Fejl af de beregnede Tryk med Størrelsen af Trykkene selv, og beregner man den tilsvarende sandsynlige Fejl af en Barometerhøjde paa 760 mm, faar man

From this Table, we perceive that the specific gravities give the pressure in the deep with a precision of from 2 to 3 millimetres mercury-pressure. The error in the gravity-factor b does not involve any error in the pressure, which amounts to half a millimetre. The probable presence of an error in the coefficient of compression for sea-water, involves an error in the pressure quite appreciable. But this error is well-nigh constant throughout the whole extent of ocean at one and the same level, so that the *differences* of pressure at the surfaces of level is wholly unaffected thereby. This refers still more forcibly to the coefficient b.

The errors in the computed differences of pressure at the surfaces of level of the deep, depend thus, practically speaking, only on the errors in the computed values of Σ. The difference in pressure between two points will have a probable error of $\sqrt{2}\left(\frac{dp}{d\Sigma}\right)d\Sigma$, the error at each point being $\pm\left(\frac{dp}{d\Sigma}\right)d\Sigma$. These probable errors are therefore: —

at a depth of 500 fathoms $1.51\sqrt{2} = 2.14$ mm.
at — 1000 — $2.14\sqrt{2} = 3.03$
at — 1500 — $2.64\sqrt{2} = 3.73$

In order to reach a precision of 1 millimetre mercury-pressure, the specific gravity would have to be determined with quadruple precision, accordingly to the 5th decimal, or the number of observations for specific gravity be so great, that the probable error of such at any one point throughout the depth of the sea be 4 times less than that we attained. Here the question merely relates to depths not exceeding 1500 fathoms.

If the probable error of the computed pressure be compared with the amount of pressure itself, and if the corresponding probable error of a barometrical height of 760 mm. be likewise calculated, we shall get: —

for 500 Favne (*fathoms*): $1.51 : (91.13 \times 760) = 0.00002181 = \frac{1}{45850}$; Bar. 0.0166 mm.
„ 1000 „ „ $2.14 : (182.62 \times 760) = 0.00001544 = \frac{1}{64763}$ „ 0.0117
„ 1500 „ „ $2.64 : (274.56 \times 760) = 0.00001263 = \frac{1}{79170}$ „ 0.0096
Normalbarometer (*Standard Barometer*): $0.01 : 760 = 0.00001318 = \frac{1}{76000}$ „ 0.0100

Sammenligningen stiller sig saaledes gunstig for Nøjagtigheden af de beregnede Tryk i Havets Dyb ligeoverfor Maalingen af Atmosfærens Tryk.

Vil man tage et fuldere Hensyn til de forskjellige

The comparison is accordingly favourable to the precision of computed pressure in the depths of the sea as contrasted with the measure of atmospheric pressure.

Should we wish to pay greater regard to the various

specifiske Vægter i de forskjellige Dyb, kan man regne med Differentsformelen:

$$\triangle p = a_o S_o \frac{1 + b\left(H_o + \frac{\triangle H}{2}\right)}{1 - \eta\left(p_o + \frac{\triangle p}{2}\right)} \triangle H.$$

der udtrykker Trykkets Tilvæxt, i Atmosfærer, i et Vandlag, hvis midlere Tæthed, ved almindeligt Lufttryk, er S_o, hvis Højde er $\triangle H$, hvis øverste Begrændsningsflade er en Niveauflade, der har Dybden H_o (under 45° Bredde) og Trykket p_o, underste Begrændsningsflade Dybden $H_o + \triangle H$ og Trykket $p_o + \triangle p$. Beregningen efter denne Formel sker lettest ved successiv Approximation ligesom efter Formelen for p Side 148.

Efter Tornøes Tabeller har jeg beregnet den gjennemsnitlige Værdi af Havvandets Tæthed for de forskjellige Dybder, idet Observationerne bleve fordelte i Grupper efter Dybden 50 til 150, 150 til 250 Favne o. s. v., inden hvilke der toges Middel saavel af Dybderne som af Tæthederne. Saaledes fremkom den følgende Tabel, første Halvdel. Tallene i den anden Halvdel ere fremkomne ved grafisk Udjevning.

specific gravities in the different depths, we can then compute with the formula of differences: —

$$\triangle p = a_o S_o \frac{1 + b\left(H_o + \frac{\triangle H}{2}\right)}{1 - \eta\left(p_o + \frac{\triangle p}{2}\right)} \triangle H.$$

which expresses the increase of pressure, in atmospheres, caused by the weight of a column of water whose mean density under ordinary atmospheric pressure is S_o, whose height is $\triangle H$, whose upper surface is a surface of level, which has the depth H_o (latitude 45°) and a pressure of p_o, its lower surface having the depth $H_o + \triangle H$ and the pressure $p_o + \triangle p$. The computation, according to this formula, is most easily made by successive approximation, as with the formula for p, page 148.

From Tornøe's Tables, I have computed the average density of the sea-water for the different depths, the observations being divided into groups, according to a depth of 50 to 150, 150 to 250 fathoms, etc., within which the mean was taken, alike of the depth and of the density. In this manner, was produced the first half of the following Table. The figures in the second half were found by a smoothing curve.

Dybde (*Depth*)	S_o	Antal Obs. (*Number of Obs.*)	Dybde (*Depth*)	S_o
			0 Fv.	1.02690
117 Fv.	1.02731	21	100	727
202	756	16	200	755
299	776	9	300	777
416	799	6	400	797
506	804	7	500	804
611	801	8	600	805
695	812	5	700	804
800	800	2	800	802
904	768	3	900	799
1006	780	1	1000	796
1110	798	4	1100	794
1205	800	2	1200	791
1316	788	3	1300	789
1407	778	2	1400	785
1511	783	3	1500	782
1607	790	1	1600	779
1695	770	3	1700	776
1760	810	1	1800	773
1861	820	1	1900	770
			2000	767

Efter Formelen for $\triangle p$ beregnedes den følgende Tabel, første Halvdel.

According to the formula for $\triangle p$, I computed the following Table, first half.

H	S_o	Δp Atm.	p Atm.	S_H	S'_H	$S_H - S'_H$
0 Fv.	1.02709	18.18570	0.0000	1.02690	1.02759	— 0.00069
100	741	18.20713	18.1857	2811	2846	— 35
200	766	18.22729	36.3928	2924	2934	— 10
300	787	18.24676	54.6201	3030	3022	+ 8
400	801	18.26506	72.8669	3136	3109	+ 27
500	805	18.28153	91.1319	3227	3197	+ 30
600	805	18.29743	109.4135	3314	3285	+ 29
700	803	18.31308	127.7109	3398	3372	+ 26
800	801	18.32860	146.0240	3482	3460	+ 22
900	798	18.34408	164.3526	3565	3547	+ 18
1000	795	18.35968	182.6967	3648	3635	+ 13
1100	793	18.37531	201.0563	3733	3722	+ 11
1200	790	18.39091	219.4316	3816	3810	+ 6
1300	787	18.40653	237.8226	3900	3898	+ 2
1400	784	18.42220	256.2291	3984	3985	— 1
1500	781	18.43790	274.6513	4068	4073	— 5
1600	778	18.45365	293.0892	4153	4160	— 7
1700	775	18.46940	311.5428	4237	4248	— 11
1800	772	18.48526	330.0122	4322	4336	— 14
1900	769	18.50113	348.4975	4407	4423	— 16
2000			366.9986	1.04493	1.04511	— 0.00018

Den virkelige Tæthed af Havvandet i Dybden H, under Trykket p er

$$S_H = \frac{S_o}{1 - \eta p}$$

Efter denne Formel ere de tilsvarende Værdier i Tabellens anden Halvdel beregnede. Sætter man S_H under Formen

$$S_H = S\,(1 + \varepsilon\,H)$$

faar man ved de mindste Kvadraters Methode

$$S_H = 1.027591\ (1 + 0.0000085248\ H).$$

De efter denne Formel beregnede Værdier ere opførte i Tabellen under S'_H, samt Forskjellerne mellem S_H og S'_H. Det er denne Formel, der ovenfor, Side 145, er benyttet ved Beregningen af Coefficienten for Tyngdens Tilvæxt med Dybet.

Dersom Søvandet ikke var sammentrykkeligt, vilde man have Trykket i Dybden H udtrykt ved Hjelp af Formelen

$$p = a_o\,\Sigma\,(1 + \tfrac{1}{2}\,b.\,H)\,H.$$

Sættes Σ = Medium af S_o i ovenstaaende Tabel = 1.0278165 og H = 2000 Favne, faar man

p = 363.9682 Atmosfærer,
medens Tabellen giver 366.9986 „
Forskjellen 3.0304 „

hvormed Trykket er øget paa Grund af Vandets Sammentrykkelighed, svarer til Trykket af

$$\frac{3.0304}{a_o\,\Sigma} = 16.66 \text{ Favne Søvand,}$$

en Størrelse, der i høj Grad overstiger saavel Lodskuddenes Nøjagtighed som Niveaufladens Afvigelse fra den med Havoverfladen parallele Flade.

Tabellens Værdier for Trykkene ere beregnede efter Differents-Formelen for $\Delta\,p$. Regner man Trykkene ud efter Integralformelen for p med Σ og sammenstiller Resultaterne, faar man

The actual density of the sea-water at the depth H, with the pressure p, is

$$S_H = \frac{S_o}{1 - \eta p}.$$

According to this formula, the corresponding values in the second half of the Table were computed. If we put S_H under the form

$$S_H = S\,(1 + \varepsilon\,H),$$

we get, by the method of the least squares,

$$S_H = 1.027591\ (1 + 0.0000085248\ H).$$

The values computed according to this formula have been entered in the Table under S'_H, together with the differences between S_H and S'_H. This too is the formula applied above, page 145, in computing the coefficient for the increase of gravity with depth.

Were sea-water non-compressible, the pressure at the depth H would be expressed by the formula

$$p = a_o\,\Sigma\,(1 + \tfrac{1}{2}\,b.\,H)\,H.$$

If Σ be put = the mean of S_o in the above Table = 1.0278165 and H = 2000 fathoms, we get

p = 363.9682 atmospheres,
whereas the Table gives 366.9986 „ .
The difference, 3.0304 „ ,

by which the pressure has been increased owing to the compressibility of water, corresponds to the pressure

$$\frac{3.0304}{a_o\,\Sigma} = 16.66 \text{ fathoms of sea-water,}$$

a quantity which far exceeds alike the precision of the soundings and the deviation of the surface of level from the surface parallel to the surface of the sea.

The values for pressure given in the Table have been computed from the difference-formula for $\Delta\,p$. If we calculate the pressure according to the integral formula for p with Σ, and compare the results, we shall get: —

H =	500 F.	1000 F.	1500 F.	2000 F.
Σ =	1.0276070	1.0278135	1.0278403	1.0278165
p_Σ =	91.1319	182.6967	274.6513	366.9986 Atm.
Tabel (*Table*) =	91.1319	182.6967	274.6513	366.9986 „
Forskjel (*Difference*) =	0.0000	0.0000	0.0000	0.0000 „
eller (*or*) =	0.00	0.00	0.00	0.00 mm Kviksølv (*mm. Mercury*).

Altsaa ingen Forskjel i Resultatet. Se ovenfor S. 149. Har man at beregne Trykket for en Række Punkter i samme Niveauflade, kan man lette og sikkre Regningen ved at anvende følgende Interpolationsformler. Man har

Hence no difference in the result. See above, p. 149. If the pressure has to be computed for a series of points in the *same* surface of level, the computation may be rendered more easy and accurate by the following formulæ of interpolation. We have

$$p = \frac{a_o \Sigma (1 + \frac{1}{2} b. H)}{1 - \frac{1}{2} \eta p} . H; \quad \left(\frac{d\,p}{d\,\Sigma}\right) = \frac{a_o (1 + \frac{1}{2} b. H)}{1 - \eta p} . H.$$

Beregnes p_{Σ_o} for en given Værdi af Σ, der falder nær Mediet af de i vedkommende Niveauflade forekommende, og som jeg vil betegne ved Σ_o, samt Værdien af $\left(\frac{d\,p}{d\,\Sigma}\right)$ efter disse Formler, saa kan man sætte

Now, supposing p_{Σ_o} to be computed for a given value of Σ, closely approaching the mean of the values occurring in the respective surface of level, and which I will indicate by Σ_o, as also the value of $\left(\frac{d\,p}{d\,\Sigma}\right)$, according to these formulæ, we can put,

$$p_\Sigma = p_{\Sigma_o} + \left(\frac{d\,p}{d\,\Sigma}\right) d\,\Sigma = p_{\Sigma_o} + \left(\frac{d\,p}{d\,\Sigma}\right) (\Sigma - \Sigma_o).$$

Udføres denne Beregning, faar man følgende Formler:

If this computation be made, we get the following formulæ: —

$$\begin{aligned}
H = 300 \text{ F.} \quad p_\Sigma &= 54.6438 + 53.23\,(\Sigma - 1.02783) \text{ Atm.} \\
500 \text{ „} \quad \text{„} &= 91.1313 + 88.87\,(\Sigma - 1.02760) \text{ „} \\
1000 \text{ „} \quad \text{„} &= 182.6229 + 178.49\,(\Sigma - 1.02740) \text{ „} \\
1500 \text{ „} \quad \text{„} &= 274.5597 + 268.88\,(\Sigma - 1.02750) \text{ „}
\end{aligned}$$

8. Tæthedsfladen.

Tænke vi os fra hvert af de forskjellige Punkter i Havets Overflade ført et Rør med stive Vægge lodret ned til Bunden og herfra til dennes dybeste Punkt, saa vilde Vandet i disse Rør være i Ligevægt, naar Trykket i det dybeste Punkt var det samme i hvert Rør. Havde Vandet i hvert Rør, eller gjennem hele Havets Masse, overalt den samme Tæthed, eller den samme Tæthed i samme Dybde, saa vilde Vandets Overflade i alle Rør stille sig lige højt, det er, det vilde, Lufttrykket forudsat ens overalt, danne en Niveauflade. Som vi have seet, er denne Betingelse ikke tilstede i Naturen. Søvandets Tæthed er forskjellig langs de forskjellige Verticallinier, og i hvert af de tænkte Rør vil den midlere Tæthed være forskjellig. Som Følge heraf vilde Overfladen i de forskjellige Rør ikke danne en Niveauflade, men stille sig saaledes, at Vandoverfladens verticale Afstand fra Bundens dybeste Punkt i hvert Rør blev omvendt proportional med dets midlere Tæthed i Røret. En mindre Tæthed vilde give en større Vandhøjde, en større Tæthed en mindre Vandhøjde. Det første vilde i vort Nordhav finde Sted under Kysterne, det sidste midt i Havet, og Overfladen vilde blive hul eller nedsunken i Midten. Betegner i hosstaaende Figur 1 NNN en Niveauflade, vilde Vandoverfladerne i Rørene indtage Fladen

8. The Surface of Density.

Let us imagine a rigid-walled tube passing vertically from every point of the sea's surface down to the bottom and along the bottom to its deepest point, the water in the said tubes would be in equilibrium, if the pressure at the deepest point were the same in every tube. Had the water in each tube, or throughout the whole mass of the sea, everywhere the same density, or the same density at the same depth, the surface of the water in all the tubes must then have an equal height; i. e., assuming the atmospheric pressure to be everywhere the same, it would constitute a surface of level. As previously pointed out, this condition is not present in nature. The density of the sea-water is different along the different vertical lines, and in each of the tubes the mean density would be different. Hence the surface in the different tubes must be such as not to constitute a surface of level, but in lieu thereof take a position so that the vertical distance of the surface of the water from the deepest point of the bottom in every tube became inversely proportional to its mean density in the tube. A lesser density would give a greater height of water, a greater density a lesser height of water. The former would occur in our North Ocean at the coasts, the latter in mid-ocean, and the surface be hollow or

OOO. Trykket i det dybeste Punkt B vilde være det samme i alle Rør, og Højden OB vilde forholde sig til Højden OB' som Tætheden i OB' til Tætheden i OB.

Overfladen OOO vilde være en Ligetryks-Flade. I det dybeste Punkt B vilde Ligetryksfladen $B'BB'$ falde sammen med Niveaufladen. I en mellemliggende Dybde vilde en Ligetryksflade $O'O'O'$ have en Krumning i Forhold til Niveaufladen, der ligger mellem Overfladens og Bundens. I alle Niveauer ville Ligetryksfladerne løfte sig mod Randen og sænke sig mod Midten. Denne Ligetryksfladernes Afvigelse fra Niveaufladerne vilde være sterkest i Overfladen, og aftage stadigt mod Bundens dybeste Punkt, hvor den bliver Nul.

Tænkte man sig nu alle Rørvægge pludselig forvandlede til Vand, af samme Tæthed som de nærmeste Vandlags, vilde Overfladen OOO ikke længere kunne bestaa. Den vilde i ethvert Punkt, undtagen i Midtpunktet, have

depressed in the middle. If, in the annexed figure 1, NNN represent a surface of level, the surfaces of the water in the tubes would coincide with the surface OOO. The pressure at the deepest point, B, would be the same in all the tubes, and the height OB would bear the same ratio to the height OB' as the density in OB' to the density in OB.

The surface OOO would be a surface of equal pressure. At the deepest point, B, the surface of equal pressure, $B'BB'$, would coincide with the surface of level. In an intermediate depth, a surface of equal pressure, $O'O'O'$, would, compared with the surface of level, have a curvature lying between that of the surface and that of the bottom. In all levels, the surfaces of equal pressure would rise towards the margin and sink towards the middle. This deviation of the surfaces of equal pressure from the surface of level would be greatest at the surface of the sea, and gradually diminish towards the deepest point of the bottom, where it is nil.

Now, were the walls of all the tubes suddenly transformed into water of the same density as that of the nearest water-stratum, the surface OOO could no longer exist. It would, at every point save the mid-point alone,

Fig. 1.

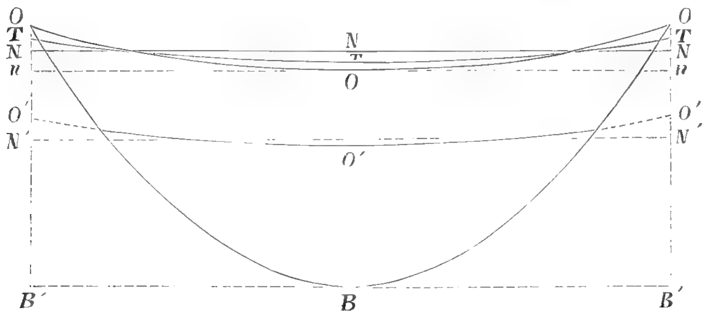
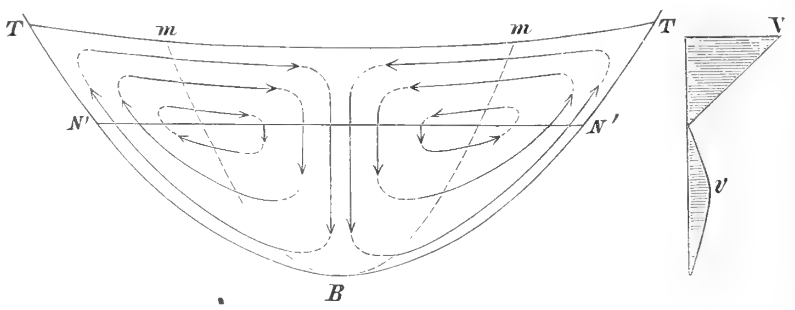


Fig. 2.



en Heldning mod den gjennem Midtpunktet gaaende Niveauflade nOn. I denne sidste blev Trykket ikke constant, men desto større, jo længere Punktet ligger fra det dybeste Punkt eller Centret. Enhver Vandpartikkel i Overfladen vilde være underkastet et Overtryk udenfra indad mod Centrum, og som Følge deraf stræbe at bevæge sig henimod dette.

Det samme vilde i det første Øjeblik finde Sted i alle Ligetryksflader. Gjennem hele Vandmassen vilde der opstaa en Strømning mod Midten.

Virkningen af denne Strømning er, at Fordybningen i Havoverfladen formindskes. Istedetfor Overfladen OOO faa vi en mindre concav Overflade TTT.

Men herved er Trykkenes Fordeling i Dybet bleven forandret. I Fladen TTT ere Skraaningerne mod Niveaufladen mindre end før, og Trykforskjellerne mindre, men Trykket er fremdeles mindst i Midten. I Niveaufladen $B'BB'$ var før constant Tryk, nu er Trykket voxet i Punktet B, over hvilket Vandmassens Højde er forøget, og sunket i Punkterne B', over hvilke Vandhøjden er formindsket.

exhibit an inclination to the surface of level, nOn, passing through the mid-point. At the latter surface the pressure would not be constant, but the greater the farther the point lay from the deepest point or from the centre. Every particle of water at the surface would be subjected to a pressure from without to within towards the centre, and hence tend to move in that direction.

The same would take place in the first instance at all surfaces of equal pressure. Throughout the whole body of water, a current would arise setting towards the central part.

The effect of this current is to diminish the depression in the sea-surface. In lieu of the surface OOO, we get a less concave surface, TTT.

But this changes the distribution of pressure in the deep. Throughout the surface TTT, the inclinations to the surface of level have diminished and the differences in pressure become less, though the pressure still continues least in the middle. Throughout the surface of level, $B'BB'$, the pressure had previously been constant; now, the pressure has increased at the point B, above

I B er et Maximum af Tryk og i B' et Minimum. Trykkets Fordeling i Bundens Niveauflade er modsat den, der finder Sted i Overfladen. I Overfladen er Ligetryksfladen fremdeles concav, ved Bunden er den convex. I en vis Niveauflade mellem Overfladen og Bunden maa Overgangen mellem disse to Tilstande finde Sted. I denne maa Ligetryksfladen falde sammen med Niveaufladen, eller Trykket være constant. Denne Flade — Grændsefladen — er altsaa ved Vandets Bevægelse fra Renderne mod Midten rykket op fra det dybeste Punkt B til et højere Niveau, $N'N'$.

which the mass of water has augmented, and has diminished at the point B', above which the height of water has experienced a decrease. At B there is a maximum of pressure, and at B' a minimum. The distribution of pressure over the surface of level of the bottom is the reverse of that at the surface. At the top-surface, the surface of equal pressure still remains concave; at the bottom it is convex. At a certain level between the surface and the bottom, the transition between these two conditions must take place. At the latter, the surface of equal pressure must coincide with the surface of level, or the pressure be constant. This surface — *the limiting surface* — has, therefore, owing to the water having moved from the border towards the middle, risen from the deepest point, B, to a higher level, $N'N'$.

Mellem Overfladen TT og Grændsefladen $N'N'$ virke Trykforskjellerne eller Gradienterne i Retning mod Midten. I Overfladen ere de størst, eller Ligetryksfladens Heldning mod Niveaufladen størst; begge blive mindre med Dybet og blive lig Nul i Grændsefladen. Imellem Grændsefladen og det største Dyb virke Trykforskjellerne eller Gradienterne fra Midten mod Renderne, og Ligetryksfladen helder udad i samme Retning. Begge ere Nul i Grændsefladen og voxe mod Dybet.

Between the upper surface, TT, and the limiting surface, $N'N'$, the differences of pressure, or the gradients, act in the direction of the centre. At the sea-surface they are steepest, or the inclination of the surface of equal pressure to the surface of level is greatest; both diminish with the depth, and are nil at the limiting surface. Between the limiting surface and the greatest depth, the difference in pressure, or the gradient, acts from the middle towards the borders, and the surface of equal pressure inclines outward in the same direction. Both are nil at the limiting surface, and increase with the depth.

Den heraf resulterende Bevægelse er fremstillet i Fig. 2. Tilstrømningen af Vand i det øvre Lag mod Midten og Udstrømningen i det nedre Lag fra Midten fremkalder en nedstigende Bevægelse i det midtre Parti. Ved Renderne af Bassinet fremkalder Vandets Bevægelse fra disse i det øvre Lag og mod disse i det nedre Lag en opadstigende Bevægelse. Den ned- og opadstigende Bevægelse virker i Retning af at formindske den af de horizontale Bevægelser i de øvre Lag flydende Stigning af Overfladen i Midten og Sænkning ved Renderne. I Grændsefladen er Bevægelsen nedadstigende eller opadstigende.

The motion which this occasions will be found represented in fig. 2. The influx of water in the upper stratum *towards* the middle and its efflux in the lower stratum *from* the middle, produce a descending motion throughout the central part. Along the margins of the basin, the motion of the water — *from* them in the upper stratum and *towards* them in the lower — gives rise to an ascending motion. The descending and ascending motions tend to diminish the rise of the surface in the middle and its depression at the margins, occasioned by the horizontal motion in the upper strata. In the limiting surface the motion is either descending or ascending.

Saaledes maatte man tænke sig Vandets Bevægelse, dersom Tyngden var den eneste virkende Kraft. Men foruden Tyngden vilde andre Kræfter komme i Virksomhed, nemlig Jordrotationens Afbøjningskraft, Centrifugalkraften, Trægheden og Frictionen. Trægheden kunne vi sætte ud af Betragtning, naar Bevægelsen er jevn

Such is the system we should reasonably ascribe to the motion of the water were gravity the sole operating force. But exclusive of gravity, other agencies will come into play, viz., the deviating force arising from the earth's rotation, centrifugal force, inertia, and friction. Inertia we may disregard altogether when the motion is uniform.

Afbøjningen ved Jordrotationen og Centrifugalkraften ville i vort Tilfælde virke i samme Retning i de øvre Lag. Naar en Vandpartikkel var kommet i Bevægelse ned over Ligetryksfladens Skraaning ad den korteste Vej til det laveste Punkt, det er langs den Linie, hvor Skraaningen — Gradienten — er størst, vil Jordrotationen drive den til højre og det desto sterkere, jo større Hastigheden, der i Begyndelsen er voxende, bliver. Naar Bevægelsen er afbøjet, har den faaet en Component lodret paa Gradientens Retning. Centrifugalkraften kommer til, forsaavidt Banen

The deflection arising from the rotation of the earth and centrifugal force, will act in this case in the same direction throughout the upper strata. On a particle of water moving down the slope of the surface of equal pressure by the shortest way towards the lowest point, i. e. along the line where the inclination — the gradient — is steepest, the rotation of the earth will force it to the right, and the faster the greater the velocity, which at first is increasing. On the motion becoming deflected, it has acquired a component perpendicular to the direction of the gradient.

bliver krum. I de nedre Lag vil Centrifugalkraften virke i modsat Retning af Jordrotationen[1]. Afbøjningen fra Gradientens Retning vil øges, indtil Virkningen af Gradientkraften, Jordrotationen, Centrifugalkraften og Frictionen frembringer en Afbøjning, under hvilken disse Kræfter holde hverandre i Ligevægt.

Den endelige Afbøjnings Størrelse beror væsentlig paa Frictionens Størrelse. Jo større denne er, desto mindre bliver Afbøjningen. I Havet er Frictionen liden, undtagen ved Kysterne og Bunden[2]. Afbøjningsvinkelen bliver derfor i det frie Hav næsten en ret Vinkel. Vandpartiklernes Baner blive næsten lodrette med Gradienternes Retning. Efterat altsaa de første Tidsrums mere centripetale Bevægelser i de øvre Vandlag have i nogen Grad udfyldt Overfladens Huling og løftet Grændsefladen op fra Bunden mod Overfladen, vil den resulterende Bevægelse ende med en Tilstand, som nærmere kan beskrives saaledes.

I Overfladen og de øvre Lag over Grændsefladen er Bevægelsen cyclonisk, i Spiraler, der føre Vandet med forholdsvis stor tangential, men ganske ringe radial (centripetal) Hastighed omkring Midtpartiets Trykminimum. Den horizontale Hastighed bliver Nul i Grændsefladen, i Midtens Trykminimum og ved Randen. Den er overhovedet størst i Overfladen og aftager mod Dybet, til den bliver Nul i Grændsefladen. I en og samme Niveauflade har den et Maximum et Steds mellem Midtens Trykminimum og Randen. Dens absolute Maximum ligger saaledes i Overfladen mellem Midten og Randen, nærmest den sidste.

I de nedre Lag, under Grændsefladen, er Bevægelsen anticyclonisk, i Spiraler, der føre Vandet fra Midtpartiet ud mod Randen. Her ere Gradienterne svagere, Centrifugalkraften virker mod Jordrotationskraften, og Frictionen er større, da Vandet kommer i langt højere Grad i Berøring med Bunden, end i de øvre Lag. Den horizontale Bevægelse bliver følgelig svagere. Den horizontale Hastighed er Nul i Grændsefladen, i Midtens Trykmaximum og ved Bunden. I en og samme Niveauflade er den størst et Steds mellem Midten og Randen. Dens absolute Maximum ligger mellem Midten og Randen i en midlere Dybde under Grændsefladen. De prikkede Linier $m\,B$ i Fig. 2 angive exempelvis de horizontale Maximumshastigheders Plads, og de horizontale Ordinater i Curven Vv deres relative Størrelse.

Den horizontale Bevægelse er ledsaget af verticale Bevægelser, der føre Vandet i det centrale Trykminimum

[1] Se min Grundzüge der Meteorologie 4. Udg. S. 231—234.
[2] Se ovenfor Side 124 og 125.

Centrifugal force adds its influence, provided the course be a curve. In the lower strata, centrifugal force will act in an opposite direction to that of the rotation of the earth.[1] The deflection from the direction of the gradient will increase till the effect of the force of the gradient, the rotation of the earth, the centrifugal force, and the friction produce a deflection by which these forces equilibrate each other.

The extent of the final deflection will mainly depend on the amount of friction. The greater this is, the less will be the deflection. In the sea we have little friction, save along the coast and at the bottom;[2] hence the angle of deflection throughout the open sea is well-nigh a right angle. The motion of the particles of water would be almost perpendicular to the direction of the gradient. Therefore, when the more centripetal motion of the first period in the upper strata of water have to some extent filled up the hollow of the surface, and lifted the limiting surface from the bottom towards the surface of the sea, the resulting motion will terminate in a state that may thus be described in detail.

At the surface and in the upper strata, above the limiting surface, the motion is cyclonic, in spirals, which carry the water with comparatively great tangential, but very trifling radial (centripetal) velocity around the pressure-minimum of the mid-part. The horizontal velocity is nil at the limiting surface, at the pressure-minimum of the middle, and at the margin. It is on the whole greatest at the surface, and diminishes with the depth, being nil at the limiting surface. At one and the same surface of level, it has a maximum somewhere between the pressure-minimum of the middle and the margin. Its absolute maximum lies accordingly at the surface, between the middle and the margin, nearest the latter.

In the lower strata, below the limiting surface, the motion is anticyclonic, in spirals, which carry the water from the mid-part towards the margin. Here the gradients are less steep, the centrifugal force acts in opposition to the force arising from the rotation of the earth, and there is greater friction, the water coming to a much greater extent in contact with the bottom than in the upper strata. Hence the horizontal motion is slower. The horizontal velocity is nil at the limiting surface, at the pressure-maximum of the middle, and at the bottom. At the same surface of level, it is greatest somewhere between the middle and the margin. The absolute maximum lies between the middle and the margin, at a medial depth below the limiting surface. The dotted lines $m\,B$ in fig. 2 might represent the loci of the horizontal maximum-velocities, and the horizontal ordinates in the curve Vv, their relative amount.

The horizontal motion is attended with vertical motions, that carry the water downward in the central pressure-

[1] See my "Grundzüge der Meterologie," 4th Ed., p. 231—234.
[2] See above, p. 124 and 125.

nedad og langs Bassinets Render opad. Den første foregaar med mindre Friction end den sidste.

Et Bevægelsessystem som det her beskrevne forudsætter en vis Fordeling af Vandets Tæthed, der resulterer i en Overflade, som afviger fra Niveaufladen og en Grændseflade i et vist Dyb mellem denne og det dybeste Punkt i Havet. Den Fordeling af Havvandets Tæthed, som var den oprindelige, vilde imidlertid ved de beskrevne Bevægelser forrykkes. Det lettere Vand fra Bredderne vilde efterhaanden af de øvre Strømninger føres til Midten og Midtens tungere af de nedre Strømninger mod Renderne.

Dersom altsaa en oprindelig ulige Fordeling af Tæthederne var den eneste eller hovedsageligste Aarsag til Havets Strømninger, vilde en Udjevning af disse Uligheder være Følgen af Bevægelsen, og denne vilde efterhaanden tabe sig for at give Plads for Ligevægt.

Men i Naturen er Forholdet det, at der er andre og sterkere Kræfter, som stadig vedligeholde den stedfindende Ulighed i Tætheden i de forskjellige Punkter af Havet. Disse Kræfter ere de af Vindene fremkaldte Strømninger i Forbindelse med Elvevand og Issmeltning paa Havet, Opvarmning og Afkjøling, Nedbør og Fordunstning. Vindene føre salt Atlanterhavsvand ind i vort Nordhav, og sprede, langs Kysterne Elvevand, fra de isfyldte Partier smeltet Isvand udover det salte. Indførselsvejene ere andre end Udførselsvejene, saa at Strømningerne, for en stor Del, ikke vende tilbage i sine gamle Baner. Men Tilførslerne og Udførslerne foregaa paa bestemte Steder, og saaledes opretholdes et constant System af Fordelingen af de ulige Tætheder (Saltholdighed saavel som Temperatur) ved de normale Vinde. Disses Virkning er meget sterkere end den, der flyder af Tæthedernes Ulighed, og den gaar, i de øvre Lag, i samme Retning.

Den Udjevning af Tæthedernes Ulighed, som de af denne fremkaldte Strømninger vilde hidføre, opvejes saaledes mere end fuldstændig af Vindstrømmene. Det kommer ikke længere end til en Tendents til Udjevning. Tæthedens ulige Fordeling bliver et constant System, og de af samme resulterende Strømninger ville finde Sted, uden at Tæthedernes Ulighed udjevnes.

Overensstemmende med disse Betragtninger, hvis Rigtighed vil fremgaa endnu klarere i det Følgende, naar vi beskrive det hele resulterende Strømsystem, sætter jeg Resultatet af Tæthedernes ulige Fordeling i Havvandet deri, at der dannes en Overflade, som afviger fra Niveaufladen. Denne kalder jeg Tætheds-Fladen. Dens Form kan findes, naar man kjender Dybden af den Flade, jeg kalder Grændsefladen. Thi i Grændsefladen, der er en Niveauflade, ere Trykkene overalt lige store, og Tæthedsfladens Højde over denne bliver omvendt proportional med de, af Observationerne givne, midlere Tætheder i de verticale Vandsøjler mellem begge Flader.

Dybden af Grændsefladen er bestemt derved, at denne Flade ligger imellem Bevægelser, der gaa i modsatte Ret-

minimum and upward along the margins of the basin. The former has less friction to overcome than the latter.

A system of motion such as here set forth, is based upon a certain distribution of the density of the water resulting in a top-surface that deviates from the surface of level and a limiting surface at a certain depth between the latter and the deepest point of the sea. The original distribution of the density of the sea-water, would however be disturbed by the motions described. The lighter water from the shores would gradually be carried by the upper currents towards the middle, and the heavier water of the middle by the lower currents towards the margins.

Hence, therefore, assuming that originally an unequal distribution of density were the sole or the chief cause of ocean-currents, an equalisation of these differences would be a necessary consequence of the motion, which must gradually yield and give way to equilibrium.

But in nature the condition is such, that other and stronger forces are found to maintain the inequality of the density in the various parts of the sea. These forces are the currents produced by the winds in conjunction with river-water and the melting of ice in the sea, also heating and cooling, precipitation, and evaporation. The winds carry salt Atlantic water into our North Ocean; they spread along the coasts river-water, and from the ice-covered parts melted ice-water above the salt-water. The passages of inlet differ from those of outlet; and hence the currents, to a great extent, do not return by their original courses. But the inflow and outflow take place in definite localities; and thus a constant system is maintained of the distribution of unequal densities (amount of salt as well as temperature) by means of the normal winds. The effect of the winds greatly exceeds that produced by unequal density, and it goes throughout the upper strata in the same direction.

The equalisation of unequal density, to which the currents occasioned by it would give rise, is accordingly more than counterbalanced by the wind-currents. It does not go farther than a tendency to equalisation. The unequal distribution of density becomes a constant system, and the currents resulting from it will be produced without equalising the differences of density.

In accordance with these views, the correctness of which will appear still more clearly in the sequel, on giving a description of the whole resulting system of currents, I put the issue of the unequal distribution of density throughout the water of the sea in the forming of a top-surface differing from the surface of level. This surface I call the *Surface of Density*. Its form may be found on knowing the depth of the surface which I call the limiting surface. For at the limiting surface, which is a surface of level, the pressure is everywhere the same, and the height of the surface of density above it will be inversely proportional to the mean density of the vertical columns of water between both surfaces given by the observations.

The depth of the limiting surface is determined by its lying between motions proceeding in opposite directions.

ninger. Den kunde ogsaa bestemmes, naar man kjendte den gjennemsnitlige Hastighed af Vandet over og under Grændsefladen. Man vilde da have Betingelsen for Vandets Continuitet udtrykt derved, at de øvre Strømningers Tversnit forholder sig til de nedre Strømningers Tversnit som disses Middelhastighed til de førstes, og af Tversnittenes indbyrdes Størrelse kunde Beliggenheden af Grændselinien mellem begge bestemmes.

At finde Middelhastigheden af Vandet i de øvre og nedre Strømme, eller Forholdet mellem begge, lader sig neppe gjøre med nogen synderlig Tilnærmelse til Nøjagtighed. Ydre og indre Friction spiller her en Rolle, hvis Virkning ikke lader sig bestemme. Vi kunne imidlertid ved Forsøg finde Grændser, inden hvilke Opgavens Løsning maa ligge.

Tænke vi os, som i Fig. 2, at et verticalt Snit gjennem Havet har Formen af en Parabel, hvis Toppunkt ligger i Havets dybeste Punkt, B, saa ville vi søge den Dybde, i hvilken Grændsefladen $N' N'$ vil ligge, dersom Gjennemsnits-Hastigheden i de øvre Lag var V og i de nedre Lag v. I saa Fald maatte Fladerummene $T\,T\,N'\,N'$ og $N'\,N'\,B$ forholde sig som v til V.

Kaldes Maximumsdybden H, Dybden af Grændsefladen h, og Havets halve Bredde i Overfladen A, i Grændsefladen a, saa har man

$$\text{det øvre Fladerum} = \frac{2}{3}\,H A - \frac{2}{3}\,(H - h)\,a$$

$$\text{det nedre} \quad " \quad = \frac{2}{3}\,(H - h)\,a$$

$$\text{altsaa} \quad \frac{H A - (H - h)\,a}{(H - h)\,a} = \frac{v}{V}.$$

$$\text{Indføres Relationen} \quad \frac{A^2}{H} = \frac{a^2}{H - h}$$

saa faar man

$$\frac{h}{H} = 1 - \left(\frac{V}{V + v}\right)^{\frac{2}{3}}$$

Sættes $H = 2000$ Favne, saa faar man

for $\frac{V}{v} = 1$	$h = 0.370\,H$	$= 740$ Favne
2	0.237	474
3	0.174	349
4	0.138	276
5	0.115	229.

Da Middelhastigheden i det nedre Fladerum maa være mindre end i det øvre, saa bliver den allerstørste Dybde, i hvilken vi kunne søge Grændsefladen, 740 Favne.

Naar man ser hen til, at i det nedre Tversnit den horizontale Hastighed er Nul rundt hele Tversnittets Omkreds, medens den i det øvre Tversnit kun paa 3 Sider er Nul, nemlig i Axen, i Grændsefladen og ved Randen, men i Overfladen har et absolut Maximum, i Forbindelse med, at Gradienterne i de nedre Lag tilhøre den Axen nærmestliggende Del af Systemet, hvor disse overhovedet ere mindre, medens de i Overfladen voxe med Afstanden fra

It might also be determined if we knew the average velocity of the water above and below the limiting surface. We should then have the condition of the water's continuity expressed by the cross-section of the upper currents having to the cross-section of the lower the same ratio as the mean velocity of the latter has to that of the former; and from the relative areas of the cross-sections, the position of the limiting line between both might be determined.

To find the mean velocity of the water in the upper and lower currents, or their ratio to each other, will hardly admit of being effected with any reasonable approach to correctness. Here, outer and inner friction play a part, the influence of which cannot be determined. Meanwhile, we can, on repeated trial, find limits within which the solution of the problem must lie.

Now, if we imagine, as shown in fig 2, a vertical section through the sea having the form of a parabola, the vertex of which is at the deepest point of the ocean-bed, B, we shall seek the depth at which the limiting surface, $N'\,N'$, will lie, assuming the average velocity in the upper strata to be V and in the lower strata v. Hence the areas $T\,T\,N'\,N'$ and $N'\,N'\,B$ must have the same ratio as v to V.

Calling the maximum depth H, the depth of the limiting surface h, and half the breadth of the sea at the surface A, at the limiting surface a, we have

$$\text{the upper area} = \frac{2}{3}\,H A - \frac{2}{3}\,(H - h)\,a$$

$$\text{the lower} \quad " \quad = \frac{2}{3}\,(H - h)\,a\,;$$

$$\text{hence} \quad \frac{H A - (H - h)\,a}{(H - h)\,a} = \frac{v}{V}.$$

$$\text{Now, since} \quad \frac{A^2}{H} = \frac{a^2}{H - h}$$

we shall get

$$\frac{h}{H} = 1 - \left(\frac{V}{V + v}\right)^{\frac{2}{3}}.$$

Putting $H = 2000$ fathoms, we get

for $\frac{V}{v} = 1$	$h = 0.370\,H$	$= 740$ fathoms
2	0.237	474
3	0.174	349
4	0.138	276
5	0.115	229

Since the average velocity in the lower area must be less than in the upper, the greatest depth at which we can seek the limiting surface will be 740 fathoms.

If we consider that in the lower cross-section the horizontal velocity is nil at the entire perimeter of the section, whereas in the upper cross-section it is nil on three sides only, viz., in the axis, at the limiting surface, and at the margin, but at the upper surface has an absolute maximum, besides that the gradients in the lower strata belong to the part of the system nearest the axis, where these on the whole are less, whereas at the

Axen til et Punkt, der ligger nærmere Randen, og med at Tæthedsforskjellerne ere mindre i Dybet og som Følge deraf ogsaa Gradienterne i de nedre Lag, vil man komme til den Slutning, at Gjennemsnitshastigheden i de nedre Lag er betydelig mindre end i de øvre Lag. Vi føres saaledes snart op paa mindre Dybder for Grændsefladen. Allerede et Forhold mellem Hastighederne som 2 til 1 rykker den op til 474 Favne og som 3 til 1 til 349 Favne. Et sterkere Forhold mellem Hastighederne har forholdsvis mindre Indflydelse paa Grændsefladens Dybde, naar vi komme op til 300 Favne, der svarer til et Forhold af $V : v = 3.622 : 1$.

Nærmere kunne vi ikke komme til Løsningen ad denne Vej. Vi maa derfor se os om efter andre Kjendemerker og undersøge, om der i Bevægelsens Retning kunde være saadanne at finde. Her møder den Vanskelighed, at Bevægelsen i Havet hovedsagelig er bestemt af Vindene, hvis Virkning overgaar og overdækker Tæthedens. At udskille den sidste bliver vistnok i de fleste Tilfælder umuligt. Dens Spor lade sig dog nok paavise, navnlig turde her henpeges paa Isothermernes Sænkning i Havets Midte og Opstigning ved Renderne, der er saa fremtrædende i Snittene Pl. X til XIII. I Projectionssnittet Pl. XXVI se vi ogsaa, paa Norges Kystbanker, den sterkeste Sammentrængning af Isothermerne ved noget over 300 Favnes Dyb, et Fænomen, der vidner om, at her lider det varme Vand i de øvre Lag, der drives frem af Vinden, en sterk Afkjøling fra koldt Vand, der stiger op fra Dybet langs Bundens Skraaning. Her turde altsaa være et Parti, der svarer til Punktet N' i Fig. 2.

I Færø-Shetland-Renden, navnlig i dens nordvestlige Halvdel (Snittene I, II, III, IV og VI, Pl. IX), ligger iskoldt Vand under varmt Vand. Det varme Vand føres af de sydvestlige Vinde ind fra Atlanterhavet mod Nordost. Det iskolde Vand har sin Rod i Nordhavets Dyb østenfor Island og Færøerne; det maa komme ind langs Rendens Nordside fra Nordost mod Sydvest. Her have vi altsaa modsatte Bevægelser i de øvre og i de nedre Lag. Grændsen mellem disse ligger omtrent paa 300 Favnes Dyb; thi indtil dette Dyb rækker det varme Atlanterhavsvand paa Wyville Thomson-Ryggen.

Jo højere Grændsefladen lægges, desto mindre Vægt tillægges Tæthedernes Ulighed som strømfrembringende Kraft. Thi jo mindre mægtigt det øvre Lag bliver, desto mindre vil Forskjellen i de verticale Vandsøjlers Vægt blive, desto mindre de deraf flydende Uligheder i Trykket. Man er saaledes muligens paa den sikkre Side, naar man lægger Grændsefladen noget højt, fremfor i en større Dybde.

Under disse Omstændigheder har jeg maattet gjøre et Valg indenfor de af Sandsynlighedshensyn optrukne Grændser. Jeg sætter Grændsefladens Dybde til 300 Favne.

surface they increase from the axis to a point nearer the margin, and that the differences of density are less in the deep, and consequently also the gradients in the lower strata, we shall arrive at the result that the average velocity in the lower strata is considerably less than in the upper. We are thus soon brought up to less depths for the limiting surface. Even a ratio of the velocities of 2 to 1 will raise it to 474 fathoms, and of 3 to 1 to 349 fathoms. A greater ratio of the velocities has comparatively less influence on the depth of the limiting surface when raised to 300 fathoms, which corresponds to a proportion of $V : v = 3.622 : 1$.

A nearer solution we cannot arrive at in this way. We must, therefore, seek other criterions, and investigate if such are to be found in the *direction* of the motion. Here, however, we meet with the difficulty that in the sea the motion is chiefly determined by the winds, the effect of which exceeds and conceals that of the density. To separate the latter will no doubt in most cases prove impossible. Still, its traces will possibly admit of being detected; here, more especially, we may call attention to the dipping down of the isotherms in the middle of the sea and their rise at the margins, so conspicuous in the sections Pl. X to Pl. XIII. In the projected section, Pl. XXVI, we also see, on the Norwegian coast banks, the greatest crowding of the isotherms in a depth of somewhat over 300 fathoms, a phenomenon clearly proving that here the warm water in the upper strata, driven forward by the wind, undergoes a considerable cooling from cold water, which ascends from the deep along the slope of the bottom. Here, accordingly, may be a part of the seabed corresponding to the point N' in fig. 2.

In the Færoe-Shetland Channel, more especially throughout its north-western half (Sections I, II, III, IV, and VI, Pl. IX), ice-cold water extends under warm water. The warm water is carried by the south-westerly winds from the Atlantic Ocean towards the north-east. The ice-cold water has its source in the deep of the North Ocean, east of Iceland and the Færoes; it must find an entrance along the north side of the channel, from the north-east to the south-west. Here, we have accordingly opposite motions in the upper and in the lower strata. The dividing plane between the two lies at a depth of about 300 fathoms; for to that depth the warm Atlantic water reaches down on the Wyville-Thomson Ridge.

The higher we place the limiting surface, the less importance we attach to the differences of density as a current-producing force. For the less deep the upper stratum, the less will be the difference of weight of the vertical columns of water, and the less the differences of pressure arising from them. Hence, we are possibly on the safe side in placing the limiting surface somewhat high, rather than at a comparatively great depth.

Under these circumstances, I was compelled to choose within the limits of probability. I take the depth of the limiting surface at 300 fathoms.

Tæthedsfladens Form, det er dens verticale Coordinater over Niveaufladen, beregnes saaledes. Efter Formelen

$$p_{300} = 54.6438 + 53.23 (\Sigma - 1.02783)$$

beregnes Trykket, i Atmosfærer, af Vandsøjlen paa 300 Favnes Højde, regnet fra Overfladen af, for en Række Stationer i Nordhavet. Ved de Stationer, hvor Dybden er mindre end 300 Favne, har jeg tænkt mig et Rør lagt langs Bunden fra Stationens Vertical til det nærmeste Punkt i 300 Favnes Dyb og taget i dette, efter Tversnittene Pl. XXXIX—XLI, den midlere Tæthed for Lagene mellem 300 Favne og 200 Favne, mellem 200 Favne og 100 Fv. o.s.v. De saaledes extrapolerede Værdier ere i Tabellerne Side 139—143 merkede med en Stjerne. Paa denne Maade har jeg ført Tæthedsfladen ind til Kysterne.

De saaledes beregnede Værdier for Trykket af en Vandsøjle af 300 Favnes Højde blive af forskjellig Størrelse. Jo større Σ, desto større Tryk. Til Grundplan for Tæthedsfladen har jeg taget Niveaufladen gjennem Overfladen paa et Sted, hvor det beregnede Tryk i 300 Favnes Dyb er 54.6438 Atmosfærer. Trykket i de andre Stationer er dels større, dels mindre end dette. Da nu Trykket i Grændsefladen skal være constant 54.6438 Atmosfærer i alle Stationer, saa betegner et mindre Tryk end dette, at Vandsøjlen paa 300 Favne er for kort til at frembringe det Tryk, som Grændsefladen skal have. Til de 300 Favnes Højde maa lægges en Vandsøjle af en saadan Højde, at dennes Tryk er ligt det manglende. Overfladen kommer altsaa over 300 Favne højere end Grændsefladen.

Ligesaa betegner en større Værdi af p_{300} end 54.6438 Atmosfærer, at den tilsvarende Vandsøjle er for tung. Den maa forkortes saameget, at dens Tryk bliver 54.6438 Atm., det er, der maa fradrages den en liden Vandsøjle, hvis Tryk er $p_{300} - 54.6438$. Overfladen kommer saaledes at ligge mindre end 300 Favne over Grændsefladen. Da Afstanden mellem Grændsefladen og Niveaufladen for Overfladen i Station 247 er 300 Favne, vil i første Tilfælde Tæthedsfladen ligge højere, i sidste Tilfælde lavere end Niveaufladen gjennem Overfladen i Station 247. Den til Trykforskjellen svarende Højdeforskjel findes af Formelen

$$dp = \frac{a_o S_o (1 - \beta \cos 2\varphi)(1 + bh)}{1 - \eta p} dh$$

hvoraf $dh = \dfrac{dp}{a_o S_o} \cdot \dfrac{1 - \eta p}{1 + bh} \cdot \dfrac{1}{1 - \beta \cos 2\varphi}$

For 300 Favne er $S_o \dfrac{1 + bh}{1 - \eta p} = 1.0305$ og, da 1 Favn er $= 1.82877$ Meter, faar man

$$dh \text{ i Meter} = \frac{10.027}{1 - \beta \cos 2\varphi} dp.$$

The form of the surface of density, i. e., its vertical co-ordinates above the surface of level, was computed as follows. According to the formula

$$p_{300} = 54.6438 + 53.23 (\Sigma - 1.02783),$$

the pressure is computed, in atmospheres, of the column of water of a height of 300 fathoms, reckoned from the surface, for a series of Stations in the North Ocean. At the Stations where the depth is less than 300 fathoms, I have supposed a tube laid down along the bottom from the vertical of the Station to the nearest point at a depth of 300 fathoms, and have taken in the said tube, from the transverse sections Pl. XXXIX to Pl. XLI, the mean density for the strata between 300 and 200 fathoms, between 200 and 100 fathoms, etc. These extrapolated values are marked with an asterisk in the Tables, page 139 to 143. In this way I have carried the surface of density up to the coasts.

The values thus computed for the pressure of a column of water 300 fathoms in height will of course be different. The greater Σ, the greater the pressure. As the base for the surface of density, I have taken the surface of level through the top-surface, in a locality where the computed pressure at a depth of 300 fathoms is 54.6438 atmospheres. The pressure at the other Stations is partly greater, partly less. Now, since the pressure at the limiting surface has to be 54.6438 atmospheres at all Stations, a pressure less than this will indicate that the column of water of a depth of 300 fathoms is too short to produce the pressure which the limiting surface requires. To the height of 300 fathoms must be added a column of water of such a height that its pressure will equal that which is wanting. The surface of the sea must accordingly lie more than 300 fathoms above the limiting surface. In like manner, a value of p_{300} greater than 54.6438 atmospheres indicates that the corresponding column of water is too heavy. It must, therefore, be shortened to such an extent as will make its pressure 54.5438 atmospheres, i. e., from off it has to be taken a short column of water whose pressure is $p_{300} - 54.6438$. The surface will accordingly lie less than 300 fathoms above the limiting surface. As the distance between the limiting surface and the surface of level for the top-surface at the Station 247 is 300 fathoms, the surface of density must in the former case lie higher, in the latter case lower than the surface of level passing through the top-surface at Station 247. The difference in height corresponding to the difference in pressure is found from the formula

$$dp = \frac{a_o S_o (1 - \beta \cos 2\varphi)(1 + bh)}{1 - \eta p} dh,$$

whence $dh = \dfrac{dp}{a_o S_o} \cdot \dfrac{1 - \eta p}{1 + bh} \cdot \dfrac{1}{1 - \beta \cos 2\varphi}.$

For 300 fathoms $S_o \dfrac{1 + bh}{1 - \eta p} = 1.0305$; and as 1 fathom $= 1.82877$ metre, we get

$$dh \text{ in metres} = \frac{10.027}{1 - \beta \cos 2\varphi} dp.$$

Da vi have beregnet Trykket af en 300 Favne dyb Vandsøjle fra Overfladen af, maa dh regnes med de Værdier af Tætheden, der svarer til 300 Favnes Dyb. Formelen for Tæthedsfladens verticale Coordinater, regnede positive opad fra Niveaufladen gjennem Overfladen i Station No. 247, bliver saaledes

Having calculated from the surface the pressure of a column of water 300 fathoms deep, dh must be computed with the values of density that correspond to a depth of 300 fathoms. The formula for the vertical co-ordinates of the surface of density reckoned positive upwards from the surface of level through the top-surface of the sea at Station No. 247, will, therefore, be

$$dh = \frac{10.027}{1 - \beta \cos 2\varphi} (54.6438 - 54.6438 - 53.23\,(\Sigma - 1.02783))$$

$$dh = \frac{10.027}{1 - \beta \cos 2\varphi} (53.23\,(1.02783 - \Sigma))$$

$$dh = \frac{533.74}{1 - \beta \cos 2\varphi} (1.02783 - \Sigma).$$

Den følgende Tabel giver Stationernes Nummer, Bredde og Længde, Værdien af Σ for 300 Favne, og Tæthedsfladens verticale Coordinater, dh, i Meter.

The following Table gives the numbers of the Stations, together with their latitude and longitude, the value of Σ for 300 fathoms and the vertical co-ordinates, dh, of the surface of density, in metres.

Tæthedsfladen.

Stat. No.	Bredde. (*Lat.*)	Længde. (*Long.*)	Σ	dh
P. 54	59° 56′	6° 27′ W.	1.02748	0.187
P. 64	61 21	3 44 W.	791	−0.043
14	62 4	2 45 E.	745	0.203
24	63 10	5 58 E.	699	0.448
32	63 10	4 51 E.	705	0.416
34	63 5	0 53 E.	796	−0.069
37	62 28	2 29 W.	787	−0.021
40	63 22	5 29 W.	776	0.037
42	63 2	10 17 W.	764	0.101
48	64 36	10 22 W.	804	−0.112
51	65 53	7 18 W.	794	−0.059
52	65 47	3 7 W.	779	0.021
94	59 8	4 38 E.	680	0.550
95	60 42	4 14 E.	684	0.528
96	66 8	3 0 E.	767	0.085
99	65 51	6 25 E.	738	0.240
107	65 21	10 44 E.	719	0.342
125	67 52	5 12 E.	773	0.053
137	67 24	8 58 E.	744	0.208
148	67 27	13 25 E.	737	0.245
176	69 18	14 33 E.	743	0.213
183	69 59	6 15 E.	779	0.021
184	70 4	9 50 E.	780	0.016
199	71 18	16 17 E.	762	0.112
206	70 45	14 36 E.	768	0.080
213	70 23	2 30 E.	780	0.016
215	70 53	2 0 W.	786	−0.016
217	71 0	5 9 W.	794	−0.059
226	70 59	7 51 W.	765	0.096
241	68 41	10 54 W.	780	0.016
243	68 32	6 26 W.	786	−0.016
245	68 21	2 5 W.	786	−0.016
247	68 5	2 24 E.	781	0.011
262	70 36	32 35 E.	771	0.064
268	71 36	36 18 E.	790	−0.037
270	72 27	35 1 E.	789	−0.031
273	73 25	31 30 E.	783	0.000
275	74 8	31 12 E.	789	−0.032

The Surface of Density.

Stat. No.	Bredde (*Lat.*)	Længde (*Long.*)	Σ	dh
284	73 1	12 58 E.	1.02777	0.032
291	71 54	21 57 E.	771	0.064
295	71 55	11 30 E.	781	0.011
296	72 15	8 9 E.	778	0.027
297	72 36	5 12 E.	780	0.016
298	72 52	1 51 E.	773	0.053
300	73 10	3 22 W.	741	0.224
302	75 16	0 54 W.	758	0.133
303	75 12	3 2 E.	781	0.011
304	75 3	4 51 E.	783	0.000
305	75 1	7 56 E.	785	−0.011
306	75 0	10 27 E.	779	0.021
308	74 57	12 43 E.	777	0.032
314	74 55	15 21 E.	767	0.085
323	72 53	21 51 E.	776	0.037
339	76 30	15 39 E.	747	0.192
342	76 33	13 18 E.	762	0.112
345	76 42	10 9 E.	777	0.032
347	76 40	7 47 E.	775	0.043
349	76 30	2 57 E.	770	0.069
350	76 26	0 29 W.	747	0.192
351	77 49	0 9 W.	726	0.304
352	77 56	3 29 E.	762	0.112
353	77 58	5 10 E.	773	0.053
355	78 0	8 32 E.	766	0.091
357	78 3	11 18 E.	723	0.320
361	79 8	5 28 E.	758	0.133
362	79 59	5 40 E.	764	0.101
363	80 3	8 28 E.	767	0.085
364	79 48	10 50 E.	756	0.144
368	78 43	8 20 E.	755	0.149
371	78 8	13 46 E.	691	0.491
H_I	73 20	9 50 W.	717	0.352
H_{II}	73 15	16 30 W.	701	0.438
H_{III}	73 13	18 10 W.	697	0.459
G_I	75 12	5 0 W.	740	0.229
G_{II}	75 4	9 10 W.	724	0.315
G_{III}	74 53	12 40 W.	708	0.400

Efter disse Værdier for dh er Kartet over Tæthedsfladen, Pl. XLII, construeret. Der er optrukket Linier for ligestore Højder over eller under Niveaufladen (Grundfladen) for hver Tiendedel Meter. Ved Hjelp af Observationer fra Pommerania-Expeditionen, i den nordlige Del af Nordsøen, udenfor Skotland, og fra de danske Fyrskibe Horns Rev og Skagens Rev er Tæthedsfladen forsøgt opconstrueret over Nordsøen indtil Kartets Sydgrændse.

Kartet viser, at Tæthedsfladen har Fordybninger nordenfor Færøerne, østenfor Island, østenfor Jan Mayen, vestenfor Beeren Eiland og i Østhavet. Disse Fordybninger hidrøre fra saltere Vand og lavere Temperatur. De ligge ligesom i en Dalsænkning, der strækker sig langs de nævnte Strøg. Fra dette Strøg af løfter Tæthedsfladen sig mod Kysterne, hvor det ferskere Vand i Overfladen forhøjer Vandspejlet, selv henimod Grønlands Østkyst, hvor Temperaturen er lav. Fra det laveste Punkt, Station No. 48, i Øst for Island, hvor $dh = -0.112$ Meter, stiger Tæthedsfladen under Grønlands Kyst til 0.46 Meter over Grundplanet, altsaa ialt henimod 60 Centimeter, under Spidsbergens Vestkyst til 0.49 Meter, altsaa ialt over 60 cm, under det sydlige Norges Vestkyst og i Skagerak samt ved Jyllands Vestkyst til 0.55 m og derover, altsaa ialt 66 cm.

Nordenfor Island, mellem denne Ø og Grønland, ligger en Indsænkning paa Ordinaten 0. Denne opstaar deraf, at Vandet, navnlig i Overfladen, er forholdsvis lidet salt saavel under Grønlands Kyst, som under Islands. Ved den første virke smeltende Drivis og Smeltevand fra det glacierede Land til at forringe Saltholdigheden i de øvre Vandlag, paa den sidste Islands mægtigste Bræ-Elve, der alle udmunde paa Nordkysten. Fordelingen i Dybet af Søvandets Tæthed under Grønland har jeg opconstrueret efter Observationerne fra "Germania" i 1869—70 fra den 74.—75. Breddegrad og fra "Sofia" i 1883 i Danmarkstrædet.

Tæthedernes Fordeling under Island, hvorfra Observationer ikke have været mig tilgjængelige, har jeg construeret overensstemmende med den, som vore Observationer have givet udenfor Norges Vestkyst mellem den 60. og 62. Breddegrad. Her udmunde ingen synderlig store Elve, saa at det nok kan hænde, at Tæthedens Tilvæxt med Dybet nordenfor Island er i Virkeligheden sterkere, end jeg har antaget. I saa Fald skulde Tæthedsfladen skraane fra Islands Kyst mod Nord endnu sterkere, end Kartet viser.

Søvandets Tæthed er betinget af dets Saltholdighed, dets Temperatur, Nedbør, Isdannelse, Issmeltning, Fordunstning. Den Tæthedsflade, jeg har fremstillet, er den, som følger af Søvandets virkelige Tæthed, saaledes som den fremgaar af Iagttagelserne. Idet vi anvende Tæthedsfladen til Beregningen af Havets gjennemsnitlige Strømninger, er der altsaa taget Hensyn til de Forandringer i

In acccordance with these values for dh, the Map of the Surface of Density, Pl. XLII, has been constructed. Lines of equal height above or below the surface of level (the base) are drawn for every tenth of a metre. By means of observations taken on the "Pommerania" Expedition in the northern part of the North Sea, off Scotland, and at the Danish light-ships Horns Rev and Skagens Rev, I have sought to construct the surface of density for the North Sea to the southern extremity of the map.

The map shows that the surface of density has depressions north of the Færoe Islands, east of Iceland, east of Jan Mayen, west of Beeren Eiland, and in the Barents Sea. These depressions arise from salter water and lower temperature. They extend, as it were, down the hollow of a valley, stretching along the said tracts. From this region the surface of density rises in the direction of the coasts, where the comparatively fresh water at the surface raises the level of the sea, even towards the east coast of Greenland, where the temperature is low. From the lowest point, Station No. 48, east of Iceland, where $dh = -0.112$ metre, the surface of density rises off the coast of Greenland to 0.46 metre above its base, accordingly in all about 60 centimetres; off the west coast of Spitzbergen to 0.49 metre, or in all more than 60 cms.; off the west coast of Southern Norway and in the Skagerak, as also along the west coast of Jutland, to 0.55 metre and above; therefore in all upwards of 66 cms.

North of Iceland, between that island and Greenland, lies a depression on the ordinate 0. It arises from the water, particularly at the surface, being less salt alike off the coast of Greenland and that of Iceland. In the former locality, melting drift-ice and water from the glaciated land tend to diminish the amount of salt in the upper strata of water; in the latter, the largest of Iceland's glacier-rivers, which all disembogue on the north coast. The distribution in the deep of the density of the sea-water off the coast of Greenland, I have constructed from observations taken by the "Germania," 1869—70, on the 74th and 75th parallels of latitude, and the "Sofia," 1883, in Denmark Strait.

The distribution of density off the coast of Iceland, a locality whence observations were not obtainable, I have constructed in accordance with that given us by our observations off the West Coast of Norway, between the 60th and the 62nd parallels of latitude. There, no rivers of any magnitude empty their water into the sea, and hence perhaps, north of Iceland, the increase of density with depth is in reality greater than assumed. In that case, the surface of density should slope, from the coast of Iceland northwards, at a greater angle than shown by the map.

The density of sea-water depends on the amount of salt, on temperature, precipitation, the formation of ice, the melting of ice, evaporation. The surface of density I have represented, is that which results from the actual density of the sea-water as found from observation. Hence, when applying the surface of density to compute the general currents of the ocean, regard has been paid to the changes

Havvandets Tæthed, som atmosfæriske Aarsager fremkalde paa de forskjellige Steder.

9. Strømfladen.

Vi have ovenfor seet, hvorledes de af Vindene fremkaldte Strømninger betinge den Overflade, jeg kalder Vindfladen. Af Vindfladens Heldninger kan man omvendt beregne Vind-Strømmenes Retning og Hastighed. Paa samme Maade fremkalder ogsaa Tæthedsfladen sit Strømsystem. Havets Overflade holdes stadig i Bevægelse baade af de herskende Vinde og ved Tæthedernes ulige Fordeling. Den resulterende Bevægelse betinger en Overflade, der bestemmes saaledes, at dens verticale Coordinater over en Niveauflade ere Summen af Vindfladens og Tæthedsfladens Coordinater i samme Punkt. Denne Flade kalder jeg Strømfladen. Af dens Heldninger kunne Havoverfladens virkelige, normale Bevægelser beregnes.

I den følgende Tabel er angivet Vindfladens og Tæthedsfladens verticale Coordinater for de samme Stationer, der have tjent til Construction af Tæthedsfladen. Vindfladens Ordinater ere tagne ud af Kartet Pl. XXXIII. Højderne ere angivne i Meter. *W* betegner Vindfladens, *D* Tæthedsfladens og *S* Strømfladens Ordinater.

in the density of the sea-water which atmospheric causes occasion in the various localities.

9. The Current Surface.

We have seen above in what manner currents produced by the winds determine the form of the surface I call the wind-surface. From the inclinations of the wind-surface, conversely, we may compute the direction and velocity of the wind-currents. In the same way, too, does the surface of density produce its system of currents. The surface of the sea is kept in continual motion, alike by the prevailing winds and by the unequal distribution of density. The resulting motion requires a surface determined by the condition that its vertical co-ordinates, reckoned from a surface of level, are the sum of the co-ordinates of the wind-surface and of the surface of density at the same point. This surface I call the *Current-Surface*. From its inclinations, the true normal motions of the sea-surface admit of being computed.

In the following Table are given the vertical co-ordinates of the wind-surface and the surface of density for the same Stations that have served to construct the surface of density. The ordinates of the wind-surface have been taken from the Map, Pl. XXXIII. The heights are given in metres. *W* denotes the ordinates of the wind-surface, *D* those of the surface of density, and *S* those of the current-surface.

Strømfladen. The Current-Surface.

Stat. No.	P. 54	P. 64	14	24	32	34	37	40	42	48	51
W	0.595	0.390	0.605	0.690	0.630	0.395	0.280	0.195	0.255	0.196	0.090
D	0.187	—0.043	0.203	0.448	0.416	—0.069	—0.021	0.037	0.101	—0.112	—0.059
S	0.782	0.347	0.808	1.138	1.046	0.326	0.259	0.232	0.356	0.084	0.031
Stat. No.	52	94	95	96	99	107	125	137	148	176	183
W	0.050	0.760	0.750	0.150	0.300	0.690	0.100	0.350	0.710	0.580	0.050
D	0.021	0.550	0.528	0.085	0.240	0.342	0.053	0.208	0.245	0.213	0.021
S	0.071	1.310	1.278	0.235	0.540	1.032	0.153	0.558	0.955	0.793	0.071
Stat. No.	184	199	206	213	215	217	226	241	243	245	247
W	0.200	0.360	0.375	0.001	0.087	0.210	0.360	0.360	0.110	0.015	0.020
D	0.016	0.112	0.080	0.016	—0.016	—0.059	0.096	0.016	—0.016	—0.016	0.011
S	0.216	0.472	0.455	0.017	0.071	0.151	0.456	0.376	0.094	—0.001	0.031
Stat. No.	262	268	270	273	275	284	291	295	296	297	298
W	0.660	0.360	0.260	0.195	0.220	0.040	0.400	0.095	0.045	0.070	0.140
D	0.064	—0.037	—0.031	0.000	—0.032	0.032	0.064	0.011	0.027	0.016	0.053
S	0.724	0.323	0.229	0.195	0.188	0.072	0.464	0.106	0.072	0.086	0.193
Stat. No.	300	302	303	304	305	306	308	314	323	339	342
W	0.345	0.465	0.350	0.290	0.220	0.155	0.160	0.195	0.160	0.445	0.360
D	0.224	0.133	0.011	0.000	—0.011	0.021	0.032	0.085	0.037	0.192	0.112
S	0.569	0.598	0.361	0.290	0.209	0.176	0.192	0.280	0.197	0.637	0.472
Stat. No.	345	347	349	350	351	352	353	355	357	361	362
W	0.270	0.300	0.430	0.520	0.570	0.480	0.400	0.340	0.435	0.470	0.495
D	0.032	0.043	0.069	0.192	0.304	0.112	0.053	0.091	0.320	0.133	0.101
S	0.302	0.343	0.499	0.712	0.874	0.592	0.453	0.431	0.755	0.603	0.596

Stat. No.	363	364	368	371	H_I	H_{II}	H_{III}	G_I	G_{II}	G_{III}
W	0.450	0.500	0.390	0.500	0.625	0.820	0.850	0.600	0.700	0.775
D	0.085	0.144	0.149	0.491	0.352	0.438	0.459	0.229	0.315	0.400
S	0.535	0.644	0.539	0.991	0.977	1.258	1.309	0.829	1.015	1.175

Strømfladen, Pl. XLIII, construeredes saaledes. Værdierne af *S* afsattes i Kartet. For hver 5. Længdegrad, Kartets Meridianer, og for hver $2^1/_2$ Breddegrad fra 55° til 80° construeredes Tversnit af Tæthedsfladen og af Vindfladen paa samme Abscisselinie, efter Kartets Maalestok. De to Fladers Ordinater adderedes (grafisk) sammen. Gjennem de saaledes fundne Punkter droges Strømfladens Tversnit. Denne Curves Skjæringslinier med Horizontallinierne i Snittet for hver Decimeter afsattes i Kartet langs de respective Meridianer og Paralleler. Gjennem de saaledes fundne Punkter droges Ligehøjdelinierne i Kartet Pl. XLIII for hver Decimeter og afpassedes i Mellemrummene efter Tabellens Værdier for *S*.

The current-surface, Pl. XLIII, was constructed as follows. The values of *S* were set off on the map. For every fifth degree of longitude, the meridians of the map, and for every two and a half degrees of latitude, from the 55th to the 80th parallel, were constructed transverse sections of the surface of density and of the wind-surface on the same line of abscissæ, according to the scale of the map. The ordinates of the two surfaces were added together (diagrammatically). Through the points thus determined were drawn the transverse sections of the current-surface. The points of intersection of this curve with the horizontal lines for every decimetre in the section, were set off on the map along the respective meridians and parallels. Through the points thus determined were drawn the lines of equal height on the map, Pl. XLIII, for every decimetre, and adjusted throughout the intermediate spaces according to the values in the Table for *S*.

Strømfladen er i Forhold til Niveaufladen en hul Flade, der har sit dybeste Punkt mellem Jan Mayen og Norge i 68°.5 N. Br. og 1° W. Lgd. I dette Punkt ligger den kun nogle faa Millimeter lavere end Kartets inderste Ligehøjdelinie, den for 0.000 Meter. Fra dette dybeste Punkt løfter Strømfladen sig til alle Sider. Den naar sin største Højde — over Niveaufladen gjennem dens dybeste Punkt — ved Norges Vestkyst og i Skagerak, hvor den stiger til over 1.4 Meter. Ved Grønland naar den en Højde af 1.4 Meter, ved Spidsbergen 1.0 Meter, ved Novaja Semlja 1.2 Meter, ved Finmarkens Kyst 0.9 Meter, ved Skotlands Kyst 1.0 til 1.1 Meter og ved Islands Nordkyst 0.6 Meter. Ved Jan Mayen er Højden 0.6 Meter, men ved Beeren-Eiland kun 0.3 Meter.

The current-surface, compared to the surface of level, is hollow, and has its deepest point between Jan Mayen and Norway, in lat. 68°.5 N and longitude 1° W. At this point, it lies but a few millimetres deeper than the map's innermost line of equal height, viz., that for 0.000 metre. From this its deepest point the current-surface rises on all sides. It reaches its greatest height — above the surface of level through its deepest point — at the West Coast of Norway and in the Skagerak, where it rises to upwards of 1.4 metre. At Greenland it reaches a height of 1.4 metre; at Spitzbergen 1.0 metre; at Novaja Semlja 1.2 metre; at the coast of Finmark 0.9 metre; at the coast of Scotland 1.0 to 1.1 metre; and at the north coast of Iceland 0.6 metre. At Jan Mayen the height is 0.6 metre; but at Beeren Eiland only 0.3 metre.

10. Strømningerne i Overfladen.

Strømfladen, Pl. XLIII, giver det bedste Billede af Vandets normale Bevægelse i Havets Overflade. Bevægelsens Retning er langs Ligehøjdelinierne, cyclonisk, med de større Højder til Højre, de mindre til Venstre, som udtrykt ved de paa Kartet satte Pilespidser. Man bemerker, at langs Norges Kyst er Niveauet faldende fra Syd mod Nord, hvad der giver en Heldning, som tillader Tyngden at overvinde Frictionen langs Kysten. Denne Heldning skyldes det fra Landet udflydende ferske Elvevand. Det samme er Tilfældet ved Grønlands Kyst, hvor Heldningen er fra Nord mod Syd, altsaa ogsaa i Bevægelsens Retning. Ogsaa ved Spidsbergen og ved Island sees, ialtfald tildels, Heldninger i Havspejlet i Retning af Vandets Bevægelse. Paa Østkysten af Skotland, ved 57°.5 N. Br., synes Heldningen i Overfladen at pege nordover, medens Bevægelsen maa foregaa langs Kysten sydover. Dette kan muligens være

10. The Currents of the Surface.

The current-surface, Pl. XLIII, gives the best representation of the normal motion of the water at the surface of the sea. The motion follows the lines of equal height, cyclonically, having the greater heights to the right, the lesser to the left, as indicated by the arrowheads in the map. We observe that along the coast of Norway the level falls from south to north, which gives an inclination allowing gravity to overcome the friction along the coast. This inclination is the result of riverwater flowing seaward from the land. A similar phenomenon occurs at the coast of Greenland, where the inclination extends from north to south; here too, therefore, in the direction of the motion. At Spitzbergen likewise, and Iceland, in some places at least, are met with inclinations of the surface of the sea in the direction taken by the water. On the east coast of Scotland, lat. 57°.5 N, the

blot tilsyneladende, idet Tæthedsfladens Heldning fra Kysten turde være noget sterkere end antaget i Kartet Pl. XLII. Eller den for den sydgaaende Strøm fornødne Vandforsyning hentes fra de dybere liggende og koldere Vandlag. Dette vilde bidrage til at forklare de forholdsvis lave Temperaturer, som vi træffe paa Skotlands Østkyst (Se Pl. XVI).

For at beregne Vandets Hastighed i Overfladen, gaa vi ud fra Formelen

$$\text{tang}\,\eta = \frac{2\,\omega \sin \varphi}{g_{45}\,(1 - \beta \cos 2\,\varphi)} \cdot u$$

hvor u er Hastigheden og η Heldningvinkelen af Overfladen i et Plan lodret paa Ligetrykslinierne. Kaldes den til Afstanden $\triangle x$, regnet langs Normalen, svarende Stigning af Overfladen $\triangle h$, saa er

$$\frac{\triangle h}{\triangle x} = \text{tang}\,\eta$$

og

$$u = \frac{\triangle h}{\triangle x} \cdot \frac{g_{45}\,(1 - \beta \cos 2\,\varphi)}{2\,\omega \sin \varphi}$$

Regnes $\triangle h$ i Meter, $\triangle x$ i Kilometer, saa faar man

$$u = \frac{\triangle h}{\triangle x} \cdot \frac{1}{1000} \cdot \frac{g_{45}\,(1 - \beta \cos 2\,\varphi)}{2\,\omega \sin \varphi} = \frac{\triangle h}{\triangle x}\,\frac{1}{2k}$$

Meter per Secund.

Størrelsen $k = 1000. \dfrac{\omega \sin \varphi}{g_{45}\,(1 - \beta \cos 2\,\varphi)}$ findes beregnet i Tabellen Side 126.

I Kartet Pl. XLIII er Højdeforskjellen mellem Ligehøjdelinierne, $\triangle h$, 0.1 Meter, og man faar

$$u = \frac{1}{20\,k\,\triangle x}; \qquad \triangle x = \frac{1}{20\,k\,u}$$

Efter denne sidste Formel er Skalaen paa Pl. XLIII beregnet. Til Venstre staar den opstigende Skala for Kilometer. Parallel med den vise den hyperboliske Curves verticale Ordinater ($\triangle x$) de Afstande mellem to Ligehøjdelinier, der svare til de forskjellige Hastigheder (u). Skalaen for disse er den horizontale Grundlinie, inddelt til at angive Hastigheden saavel i Meter pr. Secund som i Kvartmil i 24 Timer. Den yderste Hyperbel gjælder for 55° Bredde, den inderste for 80°. Ved Abscissen for 0.01 m ere, øverst til Højre, Hyperblerne for de mellemliggende 5 til 5 Grader antydede.

For at finde Strømhastigheden i et Punkt tager man altsaa med Passeren Afstanden mellem de to nærmeste Ligehøjdelinier, opsøger i Skalaen den verticale Ordinat, som passer hertil, Bredden taget i Betragtning, og aflæser paa Horizontalskalaen Hastigheden i Meter pr. Secund eller i Kvartmil i 24 Timer.

inclination of the surface would appear to point northward, whereas the motion must proceed along the coast southward. This may indeed be only apparent, since the slope of the surface of density from the coast is possibly somewhat steeper than assumed in the map, Pl. XLII. Or the supply of water necessary for the current setting south is derived from the deeper-lying and colder strata. This would go far to explain the comparatively low temperature met with off the east coast of Scotland (See Pl. XVI).

For computing the velocity of the water at the surface, we have recourse to the following formula: —

$$\tan \eta = \frac{2\,\omega \sin \varphi}{g_{45}\,(1 - \beta \cos 2\,\varphi)} \cdot u,$$

in which u represents the velocity and η the angle of inclination of the surface in a plane perpendicular to the lines of equal pressure. Now, if we call $\triangle h$ the rise of the surface corresponding to the distance $\triangle x$, reckoned along the normal, then

$$\frac{\triangle h}{\triangle x} = \tan \eta$$

and

$$u = \frac{\triangle h}{\triangle x} \cdot \frac{g_{45}\,(1 - \beta \cos 2\,\varphi)}{2\,\omega \sin \varphi}.$$

If $\triangle h$ be taken in metres, $\triangle x$ in kilometres, we shall get

$$u = \frac{\triangle h}{\triangle x} \cdot \frac{1}{1000} \cdot \frac{g_{45}\,(1 - \beta \cos 2\,\varphi)}{2\,\omega \sin \varphi} = \frac{\triangle h}{\triangle x}\,\frac{1}{2k}$$

metres per second.

The quantity $k = 1000. \dfrac{\omega \sin \varphi}{g_{45}\,(1 - \beta \cos 2\,\varphi)}$ will be found computed in the Table, p. 126.

In the map, Pl. XLIII, the difference in height between the lines of equal height, $\triangle h$, is 0.1 metre; hence we get $u = \dfrac{1}{20\,k\,\triangle x}$; $\quad \triangle x = \dfrac{1}{20\,k\,u}$.

According to this last formula, the scale, Pl. XLIII, has been computed. To the left, we have the ascending scale for kilometres. Parallel with this scale, the hyperbolical curve's vertical ordinates ($\triangle x$) show the distances between two lines of equal height that correspond to the different velocities (u). The scale for these velocities is the horizontal base-line, graduated to indicate the velocity both in metres per second and in nautical miles per 24 hours. The outermost hyperbola refers to the 55th parallel of latitude, the innermost to the 80th. At the abscissa for 0.01 m., in the upper corner to the right, the hyperbolas for the interjacent 5 to 5 degrees are marked off.

To find the velocity of the current at any given point, we measure accordingly, with the compasses, the distance between the two nearest lines of equal height, seek out on the scale the vertical ordinate corresponding to it — taking the latitude into account — and read off on the horizontal scale the velocity in metres per second or in nautical miles per 24 hours.

Mellem Færøerne og Skotland kommer det atlantiske Vand directe ind i vort Nordhav, efter at have udført en Drejning fra Retning mod NNE til E og ESE. Mellem Skotland og Færø-Shetland-Renden er Hastigheden 0.16 m. p. S. (7 Kv. i 24^h) til 0.23 m. p. S. (11 Kv. i 24^h). En Del af Strømmen gaar ned i Nordsøen, som den omkredser cyclonisk, med ringe Hastighed i den midterste Del (0.04 m. p. S.; 2 Kv.).

Langs Jyllands Vestkyst løber Strømmen, understøttet af Elvevandet fra Rhinen, Weseren og Elben, med større Fart. Ved Fyrskibet Horns Rev er dens midlere aarlige Retning og Hastighed, beregnet efter Observationerne for 1880 og 1881[1] fra S 38° E, 0.17 Knob eller 4.1 Kvartmil i 24 Timer (0.09 m. p. S). Dette stemmer, som man ser, meget godt med Kartet Pl. XLIII. Retningen er aabenbart betinget af Kystens Form, der skyder sig ud mod WNW.

I Skagerak løber Strømmen paa den jydske Side med betydelig Hastighed langs Landet mod NE. De danske Observationer fra Fyrskibet Skagens Rev for 1880 og 1881 give en aarlig Strøm-Resultant af S 39° W til N 39° E, 0.7 Knob eller 18 Kvartmil i 24 Timer (0.38 m. p. S.). Dette stemmer ganske med vort Kart.

I den inderste Del af Skagerak møder denne Strøm det højere Vandspejl, der hidrører fra Østersøens ferske Vande. I Kattegat, ved Fyrskibet Læsø Rende, løber, ifølge de danske Observationer, Strømmens Aarsresultant mod Nord, og dette er nærmere Vestkysten end Østkysten. Vi slutte deraf, at Vandet i Kattegat er, i Overfladen, i Bevægelse nordover, muligens med Undtagelse af en Del under den svenske Kyst. Den nordgaaende Bevægelse fortsætter i Skagerak langs Sveriges Kyst, og bøjer, sammen med den forbi Skagen løbende Strøm, om mod Vest og Sydvest udenfor Christianiafjordens Munding. Ved Jylland løber Strømmen understøttet af de herskende Vinde. Under den norske Kyst er Resultanten af disse omtrent Nul. Vinterens nordostlige opveje næsten Sommerens sydvestlige Vinde[2]. Men her kommer, foruden Vandet fra Østersøen, efterhaanden Vandet fra de største Elve i Norge til og forhøje Vandspejlet under Kysten. Strømmen langs Kysten betinges af Tæthedsfladens Heldning udad fra samme. Denne Strøm, der efter vort Kart løber mod Sydvest, Vest og Nordvest fra Christianiafjordens Munding til Lister og videre med en Fart af 10 Kvartmil i Døgnet (0.22 m. p. S.) er vore Søfarende vel bekjendt. Med Modvind af SW kunne de, krydsende med rebede Sejl, i nogle faa Dage komme frem fra Færder til Oxø, Lindesnes og Lister.

[1] Meteorologisk Aarbog, udgivet af det danske meteorologiske Institut.

[2] Østerr. Zeitschrift für Meteorologie 1885. S. 479.

Between the Færoes and Scotland, the Atlantic water finds direct ingress into the North Ocean, after a bend from NNE to E and ESE. Between Scotland and the Færoe-Shetland Channel, the velocity is 0.16 m. per sec. (7 nautical miles in 24 hours) to 0.23 m. per sec. (11 naut. miles in 24 hours). Part of this current flows into the North Sea, which it encircles cyclonically, with a trifling velocity in the middle (0.04 m. per sec., 2 naut. miles).

Along the west coast of Jutland, the current, reinforced by river-water from the Rhine, the Weser, and the Elbe, flows with greater velocity. At the light-ship Horns Rev, its mean annual direction and velocity, computed from the observations taken in 1880 and 1881,[1] is from S 38° E, 0.17 knots, or 4.1 nautical miles in 24 hours (0.09 m. per sec.). This, as will be seen, agrees very closely with the map, Pl. XLIII. The direction is obviously determined by the form of the coast, which juts out towards the WNW.

In the Skagerak, the current flows, on the Jutland side, with considerable velocity along the shore, towards the NE. The Danish observations taken on board the light-ship Skagens Rev for 1880 and 1881, give a resultant for the year of S 39° W to N 39° E, 0.7 knots, or 18 nautical miles in 24 hours (0.38 m. per sec.). This agrees exactly with our map.

In the inner part of the Skagerak, this current meets the higher level arising from the brackish waters of the Baltic. In the Cattegat, at the light-ship Læsø Rende, the current, i. e., its annual resultant, sets, according to the Danish observations, toward the north, and this is nearer the west than the east coast. Hence we may infer, that the water in the Cattegat, at the surface, is in motion northward, some part perhaps on the Swedish coast excepted. The north-setting motion continues, in the Skagerak, along the coast of Sweden, and bends, together with the current flowing past the Scaw, round toward the west and south-west, off the embouchure of the Christiania Fjord. Off Jutland, the current flows on, impelled by the prevailing winds. Along the Norwegian coast, the resultant of these winds is well-nigh zero. The north-eastern winds of winter almost counterbalance the south-western winds of summer.[2] But here, exclusive of the water from the Baltic, that from the largest rivers in Norway is gradually superadded, raising the level of the sea in immediate proximity to the coast. The current setting along the shore is determined by the inclination of the surface of density sloping seaward. This current, which, according to our map, flows toward the south-west, west, and north-west from the mouth of the Christiania Fjord to Lister, and farther still, with a velocity of 10 nautical miles in 24 hours (0.22 m. per sec.), is well known to mariners. Beating, with reefed sails, against a head wind from the south-west, they can advance in a few days from Færder to Oxø, Lindesnes, and Lister.

[1] Meteorologisk Aarbog, published by the Danish Meteorological Institute.

[2] Østerr. Zeitschrift für Meteorologie 1885, p. 479.

Udenfor Norges Vestkyst, mellem den 59. og 63. Breddegrad, løber Strømmen nordover med betydelig Fart, indtil 20 Kv.mil i Døgnet (0.44 m. p. S.). Her mødes Strømmen fra Østersøen, fra Atlanterhavet og fra Islands Østkyst.

Henimod Midten af Havet aftager Strømmens Hastighed raskt. I en Afstand af 300 Kilometer fra Norges Kyst er den ikke mere end 5—6 Kvmil.

Nordenfor Stad løber Strømmen langs Norges Kyst og fortsætter, følgende Continentet, langs Russekysten og Novaja Semlja. Udenfor Nordland er Hastigheden 8 Kvmil (0.17 m) til 11 Kvmil (0.23 m). Udenfor Finmarkskysten gaar den op til 16 Kvm. (0.35 m), men længere øst i Østhavet bliver den igjen ringere (8 Kvm. = 0.17 m). At den ved Novaja Semlja er saavidt høj, skyldes de ferske Vandmasser fra Hvidehavet (Dwina) og Petschora.

Langs Spidsbergens Østkyst løber Strømmen mod Syd. Mellem Spidsbergen og Beeren Eiland tager den vestgaaende Strøm fra Østhavet en mere nordlig Retning. Hastigheden er her 6 Kvm. (0.13 m). Paa Stroget ved 15° W Lgd. fandt Capt. Otto[1] i Slutningen af November og Begyndelsen af December med 14 Dages midlere Vindretning E 8° S, Hastighed 15 m. p. S. (6 Beaufort Skala) en Strøm, der satte mod N 26° W med en Fart af 11 Kvm. i 24 Timer. Den normale Vindretning og Hastighed er her (Pl. XXXI) E, lidt nordlig, 4 m. p. S.

Langs Spidsbergens Vestkyst løber Strømmen med stor Fart nordover. Efter Kartet gaar Hastigheden op til 17 Kvm. (0.36 m). Strømmen hidrører aabenbart for en stor Del fra Ferskvandet fra Spidsbergens Bræer. Da "Vøringen" dampede nordover paa disse Kanter, viste det sig, at vi avancerede med en Fart, der var 1 Knob (24 Kvm. i Døgnet) større end den, som Loggen angav.

Spidsbergstrømmen gaar, under de herskende østlige Vindes Indflydelse, efterhaanden paa sin venstre Bred over i den grønlandske Polarstrøm. Større eller mindre Partier løsrives og flyttes vestover, saaledes som vi have seet i Profilerne XXIII, Pl. XIII og XXVIII, Pl. XIV, Station No. 351 (77° 49′ N, 0° 9′ W). I Station No. 303 (75° 12′ N, 3° 2′ E, Tversnit XIX, Pl. XII), der ligger i Polarstrømmen, fandt Professor Sars, at Overfladens Fauna var atlantisk.

Den indre, Grønland nærmeste, Del af Polarstrømmen har sit Udspring i den indre Del af det arktiske Ishav. Parry's bekjendte Rejse viste, at Isen nordenfor Spidsbergen drev mod Syd. Mod Øst begrændset af det mod Syd til-

[1] Christiania Videnskabsselskabs Forhandlinger, 1873, S. 379. Petermann's Mittheilungen, 1873, S. 257.

Off the West Coast of Norway, between the 59th and 63rd parallels of latitude, the current sets northward, with considerable velocity, reaching 20 nautical miles in 24 hours (0.44 m. per sec.). Here the currents meet from the Baltic, from the Atlantic Ocean, and from the east coast of Iceland.

Towards the middle of the Norwegian Sea, the velocity of the current diminishes rapidly. At a distance of 300 kilometres from the coast of Norway, it is not more than 5—6 nautical miles.

North of Stad, the current sets along the coast of Norway, and flows on, following the line of the continent, along the shores of Russia and Novaja Semlja. Off the coast of Nordland, the velocity is from 8 to 11 nautical miles (0.17 m. to 0.23 m.) Off the coast of Finmark, it rises to 16 nautical miles (0.35 m.); but farther east, in the Barents Sea, it again diminishes (8 naut. miles = 0.17 m.). The relatively high rate at Novaja Semlja must be ascribed to the masses of fresh water from the White Sea (the Dwina) and the Peschora river.

Along the east coast of Spitzbergen, the current flows towards the south. Between Spitzbergen and Beeren Eiland, the current from the Barents Sea, setting west, takes a more northerly direction. The velocity is here 6 nautical miles (0.13 m.). In the tract about long. 15° W, Capt. Otto[1] found at the close of November and the beginning of December, with a forthnight's mean direction of the wind, E 8° S, and a mean velocity of 15 m. per sec. (6 Beaufort Scale), a current setting N 26° W, at the rate of 11 nautical miles in 24 hours. The normal direction and velocity of the wind are here (Pl. XXXI) east, a little northerly, and 4 m. per sec.

Along the west coast of Spitzbergen, the current sets with great velocity northward. According to the map, its velocity reaches 17 nautical miles (0.36 m). This current obviously originates, to a great extent, in the fresh water from Spitzbergen's glaciers. As the "Vøringen" was steaming northward in these regions, we found her speed to be greater by 1 knot (24 naut. miles in 24 hours) than the log indicated.

The Spitzbergen current, acted on by the prevailing easterly winds, passes gradually with its left border into the Greenland Polar current. Larger and smaller patches are disengaged and carried off westward, as seen in the profiles XXIII, Pl. XIII, and XXVIII, Pl. XIV, Station 351 (lat. 77° 49′ N, long. 0° 9′ W). At Station 303 (lat. 75° 12′ N, long. 3° 2′ E, transverse section XIX, Pl. XII), located in the Polar current, Professor Sars found the fauna of the surface quite Atlantic.

The inner part of the Polar current, nearest Greenland, has its origin in the inner basin of the Arctic Ocean. Parry's well-known voyage clearly showed that the ice north of Spitzbergen was drifting southward. On the east

[1] Christiania Videnskabsselskabs Forhandlinger, 1873, p. 379. Petermanns Mittheilungen, 1873, p. 257.

bagevendende atlantiske Vand, mod Vest af Grønland, sætter den grønlandske Polarstrøm mod SSW forbi Jan Mayen og senere, med mere vestlig Retning, ind i den nordlige Del af Danmarkstrædet. Hastigheden er størst ved Isgrændsen og aftager efterhaanden henimod Grønlands Kyst, hvor den er mindst. Østenfor Jan Mayen gaar Hastigheden op til 15 Kvm. (0.32 m), længere Nord, under 75° Bredde, 0° Lgd., til 7 Kvm. (0.15 m). Under Grønlands Kyst gaar Hastigheden ned til 4 Kvm. (0.09 m). De samvirkende Factorer ere her den større Vindhastighed ved Isgrændsen og den ringere specifiske Vægt af Vandet ved Kysten. Det er interessant at sammenligne disse Resultater af Beregningerne med den Skildring, som den erfarne og intelligente Polarfarer, Capt. Koldewey, giver af den Grønlandske Polarstrøm i følgende Ord[1]:

"Ved Yderkanten af Isen og i Drivisen selv, indtil de Flak, der befinde sig længere indenfor Isbarrieren, findes, mellem Bredderne 70° og 75°, en bestandig sydgaaende Strømning af gjennemsnitlig 8 til 10 Kvartmiles Fart i 24 Timer, hvilken imidlertid efter Vindene og den deraf følgende Isdrift ofte bliver merkelig afbøjet mod Øst eller Vest. Lige ved Kysten er dog — omend i Almindelighed, det er i Middel for Aaret, en Flytning af Isen og Vandet mod Syd ikke kan ganske oversees (den gjennemsnitlige Hastighed af det Isflak, hvorpaa Hansa-Mændene drev, beløb sig til 4.6 Kvm. i Døgnet) — denne svagere end ved den ydre Isgrændse".

De Drifter i Isen, som Scoresby anfører[2], give, mellem 74° og 80° N, 2°—10° W, Hastigheder af 8.5, 12—13, 14 og 20 Kvm. i Døgnet. Capt. C. Bruun har observeret med sit Skib en Drift vestenom Jan Mayen ned mod Langanes paa Island med en Fart af 10 Kvm. pr. Døgn.

En Del af Polarstrømmen fortsætter sin Vej ned mod Island. Den overvejende Del følger Grønlands Kyst gjennem Danmarkstrædet og videre til Grønlands Sydspids, hvor den gaar ind i Davisstrædet.

Strømningerne omkring Island ere meget interessante. Deres Løb er allerede for mange Aar siden beskrevet af Admiral Irminger[3]. De omkredse Island i anticyclonisk Retning. De nordlige Landes Klimatologi lærer, at det er Forholdene om Vinteren, der give Aaret dets gjennemsnitlige Character. Fastlandets Afkjøling i Modsætning til det varmere Hav fremkalder et Maximum af Lufttryk over Landet, med Landvinde, der, afbøjede til højre, omkredse Kysten i anticyclonisk Retning. Endvidere ville Elvenes Vand forhøje Vandspejlet ved Kysten, og begge disse Aarsager frembringe en Strøm i Retning af de herskende

[1] Zweite Deutsche Nordpolfahrt, Meteorologie und Hydrographie, S. 613.

[2] An Account of the Arctic Regions. I, S. 213—217.

[3] Strømninger og Isdrift ved Island. Tidsskrift for Søvæsen, 1861.

bounded by the Atlantic water returning towards the south, on the west by Greenland, the Greenland Polar current sets SSW, past Jan Mayen, and then, taking a more westerly direction, flows into the northern part of Denmark Strait. The velocity is greatest at the ice-limit, gradually diminishing towards the coast of Greenland, where it is least. East of Jan Mayen, the velocity reaches 15 nautical miles (0.32 m.), farther north — lat. 75° N, long. 0° — it is 7 naut. miles (0.15 m.). Off the coast of Greenland, the velocity diminishes to 4 naut. miles (0.09 m.). The co-operating factors are here the comparatively great wind-velocity at the ice-limit and the low specific gravity of the water at the coast. It is interesting to compare these results of the computations with the account given by Capt. Koldewey, the experienced and intelligent Arctic navigator, of the Greenland Polar current, in the following words[1]: —

"At the outer limit of the ice, and in the drift-ice itself, as far as the fields which lie at a greater distance from the ice-barrier, there is, between lat. 70° and 75°, a steady south-setting current, averaging from 8 to 10 nautical miles in 24 hours, which, however, according to the winds and the ice-drift resulting from them, often deviates remarkably towards the east or the west. Meanwhile, in immediate proximity to the coast — though as a rule, i. e., in the mean for the year, we cannot quite overlook that both ice and water are moving southward (the average rate of the ice-floe on which the Hansa-men drifted, was 4.6 nautical miles in 24 hours) — this movement is less rapid than at the outer ice-limit."

The various ice-drifts mentioned by Scoresby[2] give, between lat. 74°—80° N and long. 2°—10° W, velocities of 8.5, 12—13, 14, and 20 nautical miles in 24 hours. Capt. C. Bruun observed with his ship a drift setting from the sea west of Jan Mayen towards Langanes, Iceland, at the rate of 10 nautical miles in 24 hours.

Part of the Polar current continues its course towards Iceland. By far the greater part flows along the coast of Greenland, through Denmark Strait, and thence farther on to the southern extremity of Greenland, where it passes into Davis' Strait.

The currents round Iceland are highly interesting. Their course was many years since described by Admiral Irminger.[3] They encircle Iceland, taking an anticyclonic direction. The climatology of the northern countries teach us that it is winter that gives to the year its prevailing character. The cooling-down of the continent as contrasted with the higher temperature of the sea, gives rise to a maximum of atmospheric pressure over the land, with land-winds, which, deviating to the right, encircle the coast in an anticyclonic direction. Moreover, the water of the rivers will raise the level of the sea

[1] Zweite Deutsche Nordpolfahrt. Meteorologie und Hydrographie, p. 613.

[2] An Account of the Arctic Regions, I, p. 213—217.

[3] Strømninger og Isdrift ved Island. Tidsskrift for Søvæsen, 1861.

Vinde. Saaledes er Tilfældet ved Norges og Grønlands Kyster, saaledes ogsaa ved Islands Sydkyst, Vestkyst og Østkyst. Paa Islands Nordkyst ligge Forholdene anderledes. Havet mellem Nord-Island og Grønland er ikke varmt nok eller bredt nok til at fremkalde en Lufttryksænkning mellem begge Lande. Island kommer derfor til at træde frem som et fremskudt Udenverk foran det grønlandske Continent og slutte sig til dettes Lufttryksmaximum (Pl. XXXI). De herskende Vinde paa Nordkysten af Island blive østlige. Men paa denne Kyst er det, at alle Islands største Bræelve udmunde i Havet. Her hæve de Vandspejlet og frembringe en Heldning mod Nord i dette, som Tæthedsfladen viser (Pl. XLII). Den Heldning mod Syd, som de herskende østlige Vinde give Vindfladen, mere end opvejes af Tæthedsfladens Heldning i modsat Retning. Strømfladen faar en Heldning mod Nord, og Strømmen løber mod Øst tvertimod de herskende Vinde. Den østgaaende Strøm vedligeholder Continuiteten mellem Vestkystens nordgaaende og Østkystens sydgaaende Strøm. Mellem Island og Grønland bliver der en Indsænkning i Strømfladen, der danner Grændsen mellem Polarstrømmen og den atlantiske Strøm. Den første løber, efter Kartet, med en Fart af 5 à 6 Kvm. (0.12 m) til 14 Kvm. (0.3 m); den sidste med en Fart af 4 Kvm. (0.1 m).

Udenfor Islands Østkyst gaar Strømmen, paa Ydersiden, i Følge med den fra Polarstrømmen kommende Arm, mod Syd med en Fart af 14 Kvm. (0.3 m). Søndenfor den 65. Breddegrad svinger den mod Sydost og Øst ind i det norske Hav paa venstre Fløj af den directe Atlanterhavsstrøm.

Man lægge Isothermkartet, Pl. XVI, paa Strømkartet, Pl. XLIII, og man vil med et Øjekast se Aarsagen til Isothermernes Tungeform.

at the coast; and both of these causes produce together a current in the direction of the prevailing winds. Such is the case off the coasts of Norway and Greenland, likewise, too, along the south, west, and east coasts of Iceland. On the north coast of Iceland, the conditions are different. The sea between North Iceland and Greenland is neither warm enough nor broad enough to produce a barometric depression between the two countries. Hence, Iceland stands as an advanced outwork in front of the continent of Greenland, bounding off the high pressure of that country (Pl. XXXI). The prevailing winds on the north coast of Iceland are easterly. But on this coast it is that all the largest glacier-rivers of Iceland disembogue. Here they raise the level of the sea, and thus produce an inclination towards the north, as shown by the surface of density (Pl. XLII). The inclination towards the south which the prevailing easterly winds give the wind-surface, is more than counterbalanced in the opposite direction by the inclination of the surface of density. The current-surface gets an inclination towards the north; and the current itself sets east — in direct opposition to the prevailing winds. The current setting east maintains continuity between the north-flowing current of the west and the south-flowing current of the east coast. Between Iceland and Greenland, a depression is produced in the current-surface, constituting the boundary between the Polar and the Atlantic currents. The former of these flows at a rate of 5 or 6 to 14 nautical miles (0.12 m. to 0.3 m.), the latter at a rate of 4 nautical miles (0.1 m.).

Off the east coast of Iceland, the current — its outer side — flows in company with the arm sent off from the Polar current towards the south, at a rate of 14 nautical miles (0.3 m.). South of the 65th parallel of latitude, it bends south-east and east, entering the Norwegian Sea to the left of the direct Atlantic current.

If we place the Isothermal Map, Pl. XVI, on the Current Map, Pl. XLIII, the cause of the linguiform shape of the isotherms will be seen at a glance.

II. Strømningerne i Dybet.

Til Vejledning for Studiet af Vandets Bevægelse i Havets Dyb undersøger jeg først, hvorledes de af Tæthederne og Overfladens Form afhængige statiske Tryk ere fordelte i Niveaufladerne i forskjellige Dybder. Det er den samme Methode, som man benytter i Meteorologien, naar man construerer Isobar-Karter.

Efter Formelen $p = \frac{a_o \Sigma (1 + b\,H)}{1 - \eta p} \cdot H$

beregnes Trykket i et Punkt i en Niveauflade, hvis Dybde under den normale Havflade under 45° Bredde er H Favne. Adderer man hertil Strømfladens verticale Coordinat for samme Punkt, udtrykt i Atmosfære-Tryk, faar man det statiske Tryk i Punktet i Niveaufladen.

II. The Currents in the Deep.

As a guide to the study of the motion of the water in the depths of the sea, I first investigate in what manner the static pressure dependent on density and the form of the surface is distributed over the surfaces of level at different depths. This is precisely the method adopted in meteorology when constructing isobaric maps.

According to the formula $p = \frac{a_o \Sigma (1 + b\,H)}{1 - \eta p} \cdot H$,

the pressure is computed at a given point of a surface of level, the depth of which beneath the normal surface of the sea, on the 45th parallel of latitude, is H fathoms. Now, if we add to these figures the vertical co-ordinate of the current-surface for the same point, expressed as pres-

Er Strømfladens Højde over Overfladens Niveauflade $\triangle h$ Meter og det tilsvarende Tryk i Atmosfærer $\triangle p$, saa har man (da i Overfladen $h = 0$ og $p = 0$), naar Tætheden er S:

sure in atmospheres, we shall get the static pressure at the point of the surface of level.

If the height of the current-surface above the surface of level of the top-surface is $\triangle h$ metre, and the corresponding pressure in atmospheres is $\triangle p$, we have then (since at the surface $h = 0$ and $p = 0$), the density being S,

$$\triangle p \text{ Atm.} = \frac{a_0 S (1 - \beta \cos 2\varphi)(1 + b.h)}{1 - \eta p} \triangle h \text{ Favne } (Fms.) = \frac{a_0 S (1 - \beta \cos 2\varphi)}{1.82877} \triangle h \text{ Meter.}$$

Størrelsen af S kan variere, som Tversnittene XVII, Pl. XL, og XXVIII, Pl. XLI, vise, mellem 1.0265 (73° N. Br.) og 1.0284 (61° N. Br.). Factoren for $\triangle h$ bliver i første Tilfælde 0.09957, i sidste 0.09967. Den største Værdi af $\triangle h$ er 1.4 Meter. I dette extreme Tilfælde vilde den første Factor give $\triangle p = 0.1394$ Atm., i sidste 0.1395 Atm. Om man regnede med Factoren 0.1 fik man 0.1400 Atm. Forskjellen i Resultatet, 0.0006 eller 0.0005 Atm., svarer til Kviksølvtryk af resp. 0.46 og 0.39 Millimeter. Jeg sætter derfor

$$\triangle p \text{ Atm.} = 0.1 \ \triangle h \text{ Meter.}$$

I Niveaufladen $H = 300$ Favne have vi

$$p = 54.6438 + 53.23 \, (\Sigma - 1.02783) \text{ Atm.}$$

for 300 Favnes Vandsøjle,

Tæthedsfladen $\triangle h = \dfrac{10.027}{1 - \beta \cos 2\varphi} \cdot 53.23 \, (1.02783 - \Sigma)$ Meter,

altsaa $\triangle p = \dfrac{1.0027}{1 - \beta \cos 2\varphi} \cdot 53.23 \, (1.02783 - \Sigma)$ Atm. for Tæthedsfladen,

altsaa $p + \triangle p =$

$$54.6438 + 53.23 \, (\Sigma - 1.02783) \left(1 - \frac{1.0027}{1 - \beta \cos 2\varphi}\right).$$

Sættes $\varphi = 70^0$, faar man

$$\frac{1.0027}{1 - \beta \cos 2\varphi} = 1.00321; \ 1 - \frac{1.0027}{1 - \beta \cos 2\varphi} = -0.00321.$$

Den højeste Værdi af Σ er 1.02804. Med denne bliver $\Sigma - 1.02783 = 0.00021$ og $53.23 \, (\Sigma - 1.02783) \times \left(1 - \dfrac{1.0027}{1 - \beta \cos 2\varphi}\right) = 53.23 \times 0.00021 \times 0.00321 = 0.000034$ Atm., hvad der svarer til et Kviksølvtryk af 0.026 Millimeter, der kan sættes ud af Betragtning.

Det hele Tryk i 300 Favnes Niveauflade bliver følgelig

$$P_{300} = 54.6438 + \frac{W}{10} \text{ Atm., hvor } W \text{ er Vindfladens Højde.}$$

I Niveaufladen $H = 300$ Favne have vi saaledes følgende Tryk i Atmosfærer i de forskjellige Stationer:

The value of S can vary, as shown by the transverse sections XVII, Pl. XL, and XXVIII, Pl. XLI, between 1.0265 (lat. 73° N) and 1.0284 (lat. 61° N). The factor for $\triangle h$ will in the former case be 0.09957, in the latter 0.09967. The greatest value of $\triangle h$ is 1.4 metres. In this extreme case the former factor would give $\triangle p = 0.1394$ atm., the latter 0.1395 atm. Assuming computation with the factor 0.1, we should get 0.1400 atm. The difference in the result, 0.0006 or 0.0005 atm., corresponds to a mercury-pressure of respectively 0.46 and 0.39 millimetres. Hence I take

$$\triangle p \text{ atm.} = 0.1 \ \triangle h \text{ metre.}$$

At the surface of level $H = 300$ fathoms, we have

$$p = 54.6438 + 53.23 \, (\Sigma - 1.02783)$$

atm. for a column of water 300 fath. in height,

the surf. of density $\triangle h = \dfrac{10.027}{1 - \beta \cos 2\varphi} \cdot 53.23 \, (1.02783 - \Sigma)$ metres;

hence $\triangle p = \dfrac{1.0027}{1 - \beta \cos 2\varphi} \cdot 53.23 \, (1.02783 - \Sigma)$ atm. for the surf. of density;

and therefore $p + \triangle p =$

$$54.6438 + 53.23 \, (\Sigma - 1.02783) \left(1 - \frac{1.0027}{1 - \beta \cos 2\varphi}\right).$$

Putting $\varphi = 70^0$, we get

$$\frac{1.0027}{1 - \beta \cos 2\varphi} = 1.00321; \ 1 - \frac{1.0027}{1 - \beta \cos 2\varphi} = -0.00321.$$

The highest value of Σ is 1.02804. With this value $\Sigma - 1.02783 = 0.00021$ and $53.23 \, (\Sigma - 1.02783) \times \left(1 - \dfrac{1.0027}{1 - \beta \cos 2\varphi}\right) = 53.23 \times 0.00021 \times 0.00321 = 0.000034$ atm., which corresponds to a mercury-pressure of 0.026 millimetres, and may be neglected.

Hence the whole pressure at a surface of level at 300 fathoms will be

$$P_{300} = 54.6438 + \frac{W}{10} \text{ atm., } W \text{ denoting the height of}$$

the wind-surface.

At the surface of level $H = 300$ fathoms, we have therefore the following pressures, in atmospheres, for the various Stations.

P_{300}.

Stat. No.	P 54	P 64	14	24	32	34	37	40	42
P	54.704	54.683	54.704	54.713	54.707	54.683	54.672	54.663	54.669
Stat. No.	48	51	52	96	99	125	137	176	183
P	54.663	54.653	54.649	54.659	54.674	54.654	54.679	54.702	54.649
Stat. No.	184	199	206	213	215	217	226	241	243
P	54.664	54.680	54.681	54.644	54.652	54.665	54.680	54.680	54.655
Stat. No.	245	247	284	295	296	297	298	300	302
P	54.645	54.646	54.648	54.653	54.648	54.651	54.658	54.678	54.690
Stat. No.	303	304	305	306	308	314	342	345	347
P	54.679	54.673	54.666	54.659	54.660	54.663	54.680	54.671	54.674
Stat. No.	349	350	351	352	353	355	361	362	363
P	54.687	54.696	54.701	54.692	54.684	54.678	54.691	54.693	54.689
Stat. No.	368	H_I	H_{II}	H_{III}	G_I	G_{II}	G_{III}		
P	54.683	54 706	54.726	54.729	54.704	54.714	54.721		

Disse Værdier for Trykket ere afsatte i Kartet Pl. XLIV, og efter dem er der trukket Linier for ligestort Tryk — Isobarer — for hver Hundrededels Atmosfære. Da Trykforskjellerne i 300 Favnes Niveauflade ere de samme som Vindfladens, løbe disse Isobarer ganske som Vindfladens Ligehøjdelinier.

Førend vi studere den af Trykfordelingen foraarsagede Bevægelse i denne Niveauflade, skulle vi beregne Trykkenes Fordeling i Niveaufladerne $H = 500$ Fv., $H = 1000$ Fv. og $H = 1500$ Fv. p beregnes efter Formlerne Side 155. S er Strømfladens Ordinater, dividerede med 10.

These values for the pressure are set off on the map Pl. XLIV; and in accordance with them lines of equal pressure — isobars — have been drawn for every 0.01 of an atmosphere. The difference in pressure at a surface of level 300 fathoms deep being the same as at the wind-surface, these isobars run precisely as do the lines of equal height of the wind-surface.

Before passing on to study the motion caused by the distribution of pressure over this surface of level, we will first compute the distribution of the pressure over the surfaces of level $H = 500$ fms., $H = 1000$ fms., and $H = 1500$ fms.; p is computed according to the formulæ p. 155; S denotes the ordinates of the current-surface, divided by 10.

P_{500}

Stat. No.	P 54	P 64	14	24	32	34	37	40	42	48
Σ	1.02780	1.02810	1.02782	1.02734	1.02738	1.02817	1.02805	1.02790	1.02779	1.02804
p	91.1491	91.1757	91.1509	91.1082	91.1117	91.1821	91.1713	91.1580	91.1482	91.1705
S	0.0782	0.0347	0.0808	0.1138	0.1046	0.0326	0.0259	0.0232	0.0356	0.0084
P	91.227	91.210	91.232	91.222	91.216	91.215	91.197	91.181	91.184	91.179
Stat. No.	51	52	96	99	125	137	176	183	184	199
Σ	1.02798	1.02793	1.02781	1.02760	1.02782	1.02767	1.02755	1.02785	1.02785	1.02772
p	91.1651	91.1607	91.1500	91.1313	91.1509	91.1375	91.1269	91.1536	91.1536	91.1420
S	0.0031	0.0071	0.0235	0.0540	0.0153	0.0558	0.0793	0.0071	0.0216	0.0472
P	91.168	91.168	91.174	91.185	91.166	91.193	91.206	91.161	91.175	91.189
Stat. No.	206	213	215	217	226	241	243	245	247	284
Σ	1.02777	1.02784	1.02792	1,02796	1.02773	1.02781	1.02789	1.02791	1.02787	1.02783
p	91.1464	91.1527	91.1599	91.1634	91.1429	91.1500	91.1571	91.1589	91.1554	91.1518
S	0.0455	0.0017	0.0071	0.0151	0.0456	0.0376	0.0094	—0.0001	0.0031	0.0072
P	91.192	91.154	91.167	91.179	91.189	91.188	91.167	91.159	91.159	91.159
Stat. No.	295	296	297	298	300	302	303	304	305	306
Σ	1.02785	1.02783	1.02783	1.02774	1.02745	1.02763	1.02783	1.02786	1.02788	1.02783
p	91.1535	91.1518	91.1518	91.1438	91.1180	91.1340	91.1518	91.1545	91.1562	91.1518
S	0.0106	0.0072	0.0086	0.0193	0.0569	0.0598	0.0361	0.0290	0.0209	0.0176
P	91.164	91.159	91.160	91.163	91.175	91.194	91.188	91.184	91.177	91.169

Stat. No.	308	314	342	345	347	349	350	351	352	353
Σ	1.02780	1.02774	1.02771	1.02781	1.02779	1.02777	1.02760	1.02741	1.02770	1 02778
p	91.1491	91.1438	91.1411	91.1500	91.1482	91.1465	91.1313	91.1144	91.1402	91.1474
S	0.0192	0.0280	0.0472	0.0302	0.0343	0.0499	0.0712	0.0874	0.0592	0.0453
P	91.168	91 172	91.188	91.180	91.183	91.196	91.203	91.202	91.199	91.193

Stat. No.	355	361	362	263	368	H_I	H_{II}	G_I	G_{II}
Σ	1.02774	1.02766	1.02769	1.02771	1.02769	1.02728	1.02716	1.02747	1.02734
p	91.1438	91.1367	91.1393	91.1411	91.1393	91.1028	91.0922	91.1197	91.1082
S	0.0431	0.0603	0.0596	0.0535	0.0539	0.0977	0.1258	0.0829	0.1015
P	91.187	91.197	91.199	91.195	91.193	91.201	91.218	91.203	91.210

P_{1000}

Stat. No.	40	51	52	96	176	183	184	206	213
Σ	1.02801	1.02803	1.02805	1.02797	1.02778	1.02798	1.02797	1.02792	1.02798
p	182.7318	182.7354	182.7389	182.7246	182.6908	182.7264	182.7246	182.7157	182.7264
S	0.0232	0.0031	0.0071	0.0235	0.0793	0.0071	0.0216	0.0455	0.0017
P	182.755	182.739	182.746	182.748	182.770	182.734	182.746	182.761	182.728

Stat. No.	215	217	226	241	243	245	247	284	295
Σ	1.02798	1.02796	1.02776	1.02782	1.02793	1.02793	1.02792	1.02793	1.02795
p	182.7264	182.7228	182.6872	182.6979	182.7175	182.7175	182.7157	182.7175	182.7210
S	0.0071	0.0151	0.0456	0.0376	0.0094	—0·0001	0.0031	0.0072	0.0106
P	182.734	182.738	182.733	182.736	182.727	182.717	182.719	182.725	182.732

Stat. No.	296	297	298	300	302	303	304	305	306
Σ	1.02793	1.02786	1.02776	1.02752	1.02768	1.02785	1.02787	1.02790	1.02787
p	182 7175	182.7050	182.6872	182.6443	182.6729	182.7032	182.7068	182.7121	182.7068
S	0.0072	0.0086	0.0193	0.0569	0.0598	0.0361	0 0290	0.0209	0.0176
P	182.725	182.714	182.707	182.701	182.733	182.739	182 736	182.733	182.724

Stat. No.	308	345	347	349	350	351	352	353	355
Σ	1.02786	1.02786	1.02784	1.02782	1.02771	1.02756	1.02776	1.02782	1.02780
p	182.7050	182.7050	182.7014	182.6979	182.6783	182.6514	182.6872	182.6979	182.6943
S	0.0192	0.0302	0.0343	0.0499	0.0712	0.0874	0.0592	0.0453	0.0431
P	182.724	182.735	182.736	182.748	182.750	182.739	182.746	182.743	182.737

Stat. No.	361	H_I	H_{II}	G_I	G_{II}
Σ	1.02770	1.02740	1.02732	1.02756	1.02745
p	182.6765	182.6229	182.6087	182.6514	182.6318
S	0.0603	0.0977	0.1258	0.0829	0.1015
P	182.737	182.721	182.735	182.734	182.733

P_{1500}

Stat. No.	51	52	176	183	184	206	213	215	241
Σ	1.02805	1.02809	1.02785	1.02802	1.02800	1.02796	1.02804	1.02799	1.02783
p	274.7076	274.7184	274.6538	274.6996	274.6942	274.6834	274.7050	274.6915	274.6485
S	0.0031	0.0071	0.0793	0.0071	0.0216	0.0455	0.0017	0.0071	0.0376
P	274.711	274.726	274.733	274.707	274.716	274.729	274.707	274.699	274.686

Stat. No.	243	245	247	295	296	297	298	300	302
Σ	1.02794	1.02794	1.02793	1.02797	1.02792	1.02785	1.02776	1.02755	1.02769
p	274.6780	274.6780	274.6754	274.6861	274.6727	274.6538	274.6296	274.5732	274.6108
S	0.0094	—0.0001	0.0031	0.0106	0.0072	0.0086	0.0193	0.0569	0.0598
P	274.687	274.678	274.679	274.697	274.680	274 662	274.649	274.630	274.671

Stat. No.	304	305	306	308	345	347	349
Σ	1.02785	1.02787	1.02785	1.02785	1.02785	1.02784	1.22782
p	274.6538	274.6592	274.6538	274.6538	274.6538	274.6512	274.6458
S	0.0290	0.0209	0.0176	0.0192	0.0302	0.0343	0.0499
P	274.683	274.680	274.671	274.673	274.684	274.686	274.696
Stat. No.	350	351	352	353	H_I	H_{II}	G_I
Σ	1.02774	1.02761	1.02777	1.02781	1.02746	1.02741	1.02759
p	274.6243	274.5893	274.6323	274.6431	274.5489	274.5355	274.5839
S	0.0712	0.0874	0.0592	0.0453	0.0977	0.1258	0.0829
P	274.696	274.677	274.692	274.688	274.647	274.661	274.667

Værdierne for P_{500}, P_{1000} og P_{1500} ere afsatte i Karterne Pl. XLV, XLVI og XLVII, og derefter ere Isobarerne trukne.

For at finde det System af horizontale Bevægelser, altsaa Bevægelser i Niveaufladen, der svarer til Isobar-Systemet, kunde man gaa frem ligesom i Meteorologien, og anvende Formlerne for retliniede æquidistante Isobarer, under Forudsætning af at Frictionen var proportional med Hastigheden. Kaldes Gradientkraften ($\mu\,G$ i Meteorologien) G, Massen af en Kubikmeter Vand ϱ, Afbøjningsvinkelen mellem Gradientens Retning (lodret paa Isobaren, fra det højere mod det lavere Tryk) og Bevægelsens Retning α, Jordens Omdrejningshastighed ω, Bredden φ, Frictionscoefficienten k og Hastigheden i Meter per Secund u, saa har man i saa Fald:

$$\frac{G}{\varrho} \sin \alpha = 2\,\omega \sin \varphi \,.\, u$$

$$\frac{G}{\varrho} \cos \alpha = k \,.\, u$$

Kaldes Afstanden (i Meter) langs Gradienten $\triangle x$, og den dertil svarende Trykforskjel i Kilogram (henført til den virkelige Tyngde paa Stedet) $\triangle p$,

saa har man

$$G = \frac{\triangle p^{kg}}{\triangle x^{m}}.$$

Da en Kubikmeter Kviksølv vejer 13595.9 Kilogram, og en Atmosfære er lig Trykket paa en Kvadratmeter af en Kviksølvsøjle af 0.76 Meters Højde (ved 0^0 og Normaltyngden), bliver, naar Trykket regnes i Atmosfærer,

$$\triangle p^{kg} = 13595.9 \times 0.76\ \triangle p^{at} = 10333\ \triangle p^{at}.$$

Kaldes Søvandets virkelige, af Sammentrykningen paavirkede, Tæthed S, vejer en Kubikmeter Søvand 1000 S Kilogram.

Er g_{45} Normaltyngden, har man altsaa

$$\varrho = \frac{1000\,S}{g_{45}}.$$

Indsættes disse Værdier i Bevægelsesligningerne, faar man

The values for P_{500}, P_{1000}, and P_{1500} are set off on the maps, Pl. XLV, XLVI, and XLVII, and the isobars drawn accordingly.

In order to find the system of horizontal motions, or the motions at the surface of level corresponding to the isobar-system, one might proceed as in meteorology, and apply the formulæ for straight equidistant isobars, assuming the friction proportional to the velocity. Now, if we call the force of the gradient ($\mu\,G$ in meteorology) G, the mass of a cubic metre of water ϱ, the angle of deviation between the direction of the gradient (perpendicular to the isobar, from the higher to the lower pressure) and the direction of the motion α, the angular velocity of the rotation of the earth ω, the latitude φ, the friction-coefficient k, and the velocity in metres per second u, then

$$\frac{G}{\varrho} \sin \alpha = 2\,\omega \sin \varphi \,.\, u$$

$$\frac{G}{\varrho} \cos \alpha = k \,.\, u$$

Now, if we call the distance, in metres, along the gradient $\triangle x$, and the difference in pressure corresponding to it, in kilogrammes (referred to the true gravity at the place), $\triangle p$,

we have

$$G = \frac{\triangle p^{kg}}{\triangle x^{m}}.$$

As a cubic metre of mercury weighs 13595.9 kilogrammes, and an atmosphere is equal to the pressure on a square metre of a column of mercury, 0.76 metre in height (at 0^0 and standard gravity), then, assuming the pressure to be computed in atmospheres,

$$\triangle p^{kg} = 13595.9 \times 0.76\ \triangle p^{at} = 10333\ \triangle p^{at}.$$

Calling the actual density of sea-water, acted on by compression, S, a cubic metre of sea-water weighs 1000 S kilogrammes.

With g_{45} as the standard gravity, we have therefore

$$\varrho = \frac{1000\,S}{g_{45}}.$$

If these values be substituted into the equations of motion, we get

$$\frac{10333.\ \triangle p^{at}}{1000.\ S.\ \triangle x^{m}} \cdot g_{45} \sin \alpha = 2\, \omega \sin \varphi \cdot u$$

$$\frac{10333.\ \triangle p^{at}}{1000.\ S.\ \triangle x^{m}}\, g_{45} \cos \alpha = k \cdot u$$

og altsaa (*and hence*) $u = 10.333 \dfrac{\triangle p^{at}}{\triangle x^{m}} \cdot \dfrac{g_{45} \sin \alpha}{2\, \omega \sin \varphi .\ S} = \dfrac{694772}{S} \cdot \dfrac{\triangle p^{at}}{\triangle x^{m}} \dfrac{\sin \alpha}{\sin \varphi}.$

Regner man $\triangle x$ i Kilometer, har man

Computing $\triangle x$ in kilometres, we get

$$u = \frac{694.77}{S} \cdot \frac{\triangle p^{at}}{\triangle x^{km}} \cdot \frac{\sin \alpha}{\sin \varphi}$$

$$\operatorname{tang} \alpha = \frac{2\, \omega \sin \varphi}{k}.$$

I Overfladen have vi (Side 167) regnet med Trykhøjden $\triangle h$ Meter istedetfor med Trykdifferentsen $\triangle p$ i Atmosfærer. Begge Formler ere identiske. Vi have nemlig i Overfladen

At the surface, we have calculated (p. 167) with the height of pressure $\triangle h$ metre instead of with the difference in pressure $\triangle p$ in atmospheres. Both formulæ are identical. For we have at the surface

$$\triangle p^{at} = a_o\, S\, (1 - \beta \cos 2\, \varphi)\, \triangle h^{Fv} = \frac{a_o}{1.8288}\, S\, (1 - \beta \cos 2\, \varphi)\, \triangle h^{m} = \frac{S\, (1 - \beta \cos 2\, \varphi)}{10.333} \triangle h^{m}$$

altsaa (*therefore*) $G = 10333 \dfrac{\triangle p^{at}}{\triangle x^{m}} = \dfrac{10333}{10.333}\, S.\, \dfrac{\triangle h^{m}}{\triangle x^{m}} (1 - \beta \cos 2\, \varphi).$

$$\varrho = \frac{1000\ S}{g_{45}},$$

$$\frac{G}{\varrho} = \frac{\triangle h^{m}}{\triangle x^{m}} (1 - \beta \cos 2\, \varphi)\, g_{45},$$

$$u = \frac{G}{\varrho} \cdot \frac{\sin \alpha}{2\, \omega \sin \varphi} = \frac{\triangle h^{m}}{\triangle x^{m}} \cdot (1 - \beta \cos 2\, \varphi)\, g_{45} \cdot \frac{\sin \alpha}{2\, \omega \sin \varphi} = \frac{\triangle h^{m}}{\triangle x^{m}} \cdot \frac{g_{45}\, (1 - \beta \cos 2\, \varphi)}{2\, \omega \sin \varphi} \cdot \sin \alpha;$$

hvilken Formel er identisk med Formelen for Overfladen Side 167, naar Frictionen sættes = 0 og α = 90°.

Ved Anvendelsen af Ligningen for Hastigheden u kan man sætte for 300 Favnes Dyb S = 1.0302

„ 500	—	—	1.0320
„ 1000	—	—	1.0364
„ 1500	—	—	1.0407

efter Tabellen for de udjevnede Værdier for Tætheden, Side 154.

I Karterne Pl. XLIV til XLVII ere Isobarerne optrukne for hver 0.01 Atmosfære. Sættes $\triangle p = 0.01$, saa faar man følgende Regne-Formler, der give Hastigheden u i Meter per Secund, naar Afstanden mellem Isobarerne er $\triangle x$ Kilometer.

and this formula is identical with the formula for the surface, page 167, putting the friction = 0 and α = 90°.

By applying the equation for the velocity u, we can put for a depth of 300 fathoms S = 1.0302,

„	—	„ 500	—	1.0320,
„	—	„ 1000	—	1.0364,
„	—	„ 1500	—	1.0407,

according to the Table of equalized values for density, page 154.

In the maps Pl. XLIV to Pl. XLVII, the isobars are drawn for every 0.01 of an atmosphere. Putting $\triangle p = 0.01$, we get the following computation-formulæ, which give the velocity u in metres per second, when the distance between the isobars is $\triangle x$ kilometres.

for 300 Favne (*Fms.*) $u = 6.7434 \dfrac{\sin \alpha}{\triangle x^{km} \sin \varphi}$ $\log 6.7434 = 0.82888,$

500 — $u = 6.7322 \dfrac{\sin \alpha}{\triangle x^{km} \sin \varphi}$ $\log 6.7322 = 0.82816,$

1000 — $u = 6.7036 \dfrac{\sin \alpha}{\triangle x^{km} \sin \varphi}$ $\log 6.7036 = 0.82631,$

1500 — $u = 6.6759 \dfrac{\sin \alpha}{\triangle x^{km} \sin \varphi}$ $\log 6.6759 = 0.82451.$

Disse Formler faa imidlertid kun en meget indskrænket Anvendelse.

Meanwhile these formulæ will have but a very limited application.

Havets Dybde er meget ringe i Forhold til dets horizontale Udstrækning. Den største Del af Bevægelsen maa derfor foregaa i horizontal Retning, altsaa langs Ligedybde-Linierne (Isobatherne), ligesom Strømmen i Overfladen langs Kysterne. Hvor Isobarerne gaa langs Isobatherne, og ude i det frie Hav, kunne Formlerne faa Anvendelse, forudsat at Isobarerne ikke frembyde sterkere Krumninger og sterkere Variationer i deres indbyrdes Afstand. I Dybderne 300 og 500 Favne opfyldes disse Betingelser tildels, navnlig i Polarstrømmen. I de større Dybder ligge Isobarerne jevnlig tvers paa Isobatherne. Dette sidste Tilfælde er analogt med Vandets Bevægelse i en Elv, hvor Gradienten peger i Elvens egen Retning, og Bevægelsens Hastighed er betinget af Gradientens eller Heldningens og Frictionens Størrelse.

I de større Dybder maa Bevægelsen for en meget stor Del foregaa i Retninger, der danne smaa Vinkler med Gradienterne. I de mindre Dybder kan, som Isobarsystemerne indtil 500 Favnes Dyb vise, Bevægelsen idetheletaget foregaa cyclonisk omkring et Minimum af Tryk, der ligger forholdsvis centralt i Havet. I de dybere Lag derimod blive de mere radiale Bevægelser fra de Steder, hvor Trykket er størst, henimod de Steder, hvor Trykket er mindst, de overvejende. Men i Maximumspartierne maa Bevægelsen være nedadstigende og i Minimumspartierne opadstigende, og disse verticale Bevægelser befordres i fremtrædende Grad ved den nævnte radiale Retning af de horizontale Bevægelser. Som en ligefrem Følge af Vandets Continuitet ville igjen de verticale Bevægelser i de dybere Lag indvirke paa Bevægelsen i de højere Lag. De nedstigende Bevægelser i Dybet drage de øvre Vandlag efter sig, de opstigende ville drive dem til Side.

Vi have directe Bevis for disse Virkninger af Trykkets Fordeling i de dybere Lag i Temperaturens og Saltholdighedens Fordeling. Da Strømningerne i vort Nordhav hovedsagelig foregaa i meridional Retning, er det Verticalsnittene for Temperaturen og for den specifiske Vægt langs Meridianerne, der lade Aarsagsforbindelsen fremtræde klarest.

Man sammenstille Snittene XXVIII Pl. XIV og Pl. XXXVIII, der gaa langs Greenwich Meridian, med Kartet Pl. XLVI og Pl. XLVII. Ved Havbækkenets sydlige Rand er der i disse Dybder, 1000 og 1500 Favne, et Maximum af Tryk. Samtidig se vi Isothermerne sænke sig og Saltholdigheden aftage fra et absolut Maximum. Der er følgelig her en nedstigende Bevægelse af varmere og saltere Vand. Denne Bevægelse vedvarer, efter Isothermernes Vidnesbyrd, til 65°.5 N. Br.

I 68° Bredde eller lidt derover have vi et Minimum af Tryk. Mod dette Parti løfte Dybets Isothermer sig og de have her sine Toppe, medens Saltholdigheden viser et absolut Minimum. Her have vi altsaa en opstigende Bevægelse af koldere og mindre saltholdigt Vand.

The depth of the sea is very trifling compared to its horizontal extent. Hence the motion must in greater part take a horizontal direction, viz., along the lines of equal depth (isobaths), as with the current at the surface along the coasts. Where the isobars run parallel to the isobaths, and out at sea, the formulæ can be applied, provided the isobars have no sharp curves or sudden variations in their distance from each other. At the depths 300 and 500 fathoms these conditions are partially complied with, in particular throughout the Polar current. In greater depths, the isobars lie as a rule straight across the isobaths. This last case is analogous with the motion of the water in a river, where the gradient points in the same direction as the river flows, and the velocity of the motion is determined by the steepness of the gradient or the inclination, and by the amount of friction.

In the greater depths, the motion must to a very great extent proceed in directions forming but small angles with the gradients. In the lesser depths, the motion can, as shown by the isobar-systems down to a depth of 500 fathoms, proceed on the whole cyclonically, round a minimum of pressure, that occupies a comparatively central position in the sea. Throughout the deeper strata, on the other hand, the more radial motions, from the localities where the pressure is greatest to those where the pressure is least, will be found to prevail. But in the maximum-regions the motion must be downward, in the minimum-regions upward; and these vertical motions are to a great extent furthered by the radial direction of the horizontal motion. Again, as a direct consequence of the water's continuity, the vertical motions in the deeper strata will act upon the motion in the higher strata. The downward motions in the deep must draw after them the upper strata; the upward will force them aside.

We have direct proof of these effects of the distribution of pressure throughout the deeper strata in the distribution of temperature and salinity. The currents in the North Ocean taking chiefly a meridional direction, it is the vertical sections for temperature and specific gravity along the meridians that give the clearest insight into the causal connection.

Let us compare the sections XXVIII, Pl. XIV and Pl. XXXVIII, extending along the meridian of Greenwich, with the maps Pl. XLVI and Pl. XLVII. At the southern margin of the sea-basin, we have in these depths, 1000 and 1500 fathoms, a maximum of pressure. At the same time, the isotherms are found to descend, and the amount of salt diminishes from an absolute maximum. Hence, hereabouts there must be a downward motion of warmer and salter water. This motion continues, judging from the isotherms, up to lat. 65°.5 N.

On the 68th parallel of latitude, or a little higher, occurs a minimum of pressure. Towards this part of the sea, the isotherms of the deep are found to rise and to have here their summits, whereas the amount of salt exhibits an absolute minimum. Here, accordingly, we have an upward motion of colder water containing a less proportion of salt.

Under 70⁰ til 71⁰ Bredde have vi et Maximum af Tryk. Her se vi Dybets Isothermer bøje sig nedad, og fremkalde et Temperaturmaximum ved Bunden, paa samme Tid som Saltholdigheden ogsaa viser et Maximum. Vi have med andre Ord en nedstigende Bevægelse af varmere og saltere Vand.

Under 73⁰ til 74⁰ Bredde have vi, paa Nordsiden af Tverryggen, i Svenskedybet, et Minimum af Tryk i de dybere Lag. Samtidig stige Isothermerne her opad og Isothermen for —1⁰.6 naar sin største Højde under 74⁰ Bredde, medens Saltholdigheden synker til et Minimum. Det er en opstigende Bevægelse af koldt og saltfattigere Vand.

Under 76⁰.5 Bredde have vi et Maximum af Tryk. Isothermerne have her et Minimum af Højde, Saltholdigheden har et Maximum. Der er en nedstigende Bevægelse af varmere og saltere Vand.

Vende vi nu vor Opmerksomhed paa Snittet XXIX efter Meridianen 10⁰ E, Pl. XV, og sammenligne det med Karterne Pl. XLVI og XLVII.

Under 70⁰ Bredde have vi Maximum af Tryk. Isothermerne sænke sig sterkt mod Dybet.

Under 72⁰ til 73⁰ Bredde er et Minimum af Tryk. Dybets Isothermer ere løftede til en Top.

Sammenligne vi Snittet XXX, Pl. XV, med Isobarkarterne, saa finde vi, i Meridianen 10⁰ W, Jan Mayen Rendens Sydside optaget af temmelig koldt Vand, medens dens Nordside, under Indflydelse af Trykmaximet under 70⁰, har varmere, nedstigende Vand. Nordenfor Jan Mayen kommer man paa et Minimum af Tryk. Her løfte Dybets Isothermer sig op.

Trykkets Maxima ere saaledes gjennemgaaende ledsagede af nedstigende Bevægelser af varmere og saltere Vand, Trykkets Minima af opstigende Bevægelser af koldere og saltfattigere Vand. Dette er i Overensstemmelse med, at Temperaturen i Havet er højest i de øvre Lag og lavest i de dybere. I Atmosfæren er det omvendte Tilfældet. Her ere derfor de barometriske Minima ledsagede af opstigende Strømme af varmere og fugtigere Luft og de barometriske Maxima af nedstigende Strømme af koldere og tørrere Luft. Fra Jordens af Solen opvarmede Overflade udgaa de varmere Strømninger saavel i Atmosfæren som i Havet.

Af Meridiansnittene XXVIII, XXIX og XXX ser man, at Isothermerne i de øvre Lag, saavel i 500 Favne som i 300 Favne, følge som Regel de Bøjninger, som disse Linier have i de beskrevne dybere Lag. Navnlig er Isothermernes Bøjning nedad i 70⁰ til 71⁰ Bredde, opad i 73⁰ til 75⁰ Bredde og nedad i 76⁰ til 77⁰ Bredde udpræget, især i Snittet efter Greenwich Meridian. Saltholdigheden (Pl. XXXVIII) viser tilsvarende Forhold. De sterkere verticale Bevægelser i Dybet foraarsage altsaa tilsvarende verticale Bevægelser i de øvre Lag.

From the 70th to the 71st parallel of latitude, we have a maximum of pressure. Here, the isotherms of the deep are seen bending downwards, and thus produce a maximum of temperature at the bottom, the amount of salt also showing a maximum. In other words, we have a downward motion of warmer and salter water.

From the 73rd to the 74th parallel of latitude, we have, on the north side of the Transverse Ridge, in the Swedish Deep, a minimum of pressure throughout the deeper strata. At the same time, the isotherms here rise upwards; and the isotherm for —1⁰.6 reaches its greatest height on the 74th parallel of latitude, whereas the amount of salt sinks to a minimum. It is an upward motion of cold water containing a comparatively small proportion of salt.

In latitude 76⁰.5, we have a maximum of pressure. The isotherms have here a minimum of height; the amount of salt exhibits a maximum. There is a downward motion of warmer and salter water.

Let us now turn our attention to section XXIX, extending along the meridian long. 10⁰ E, Pl. XV, and compare it with the maps Pl. XLVI and Pl. XLVII.

On the 70th parallel of latitude, we meet with a maximum of pressure. The isotherms dip down towards the deep.

In latitude 72⁰ to 73⁰, we have a minimum of pressure. The isotherms of the deep rise to a summit.

Let us compare section XXX, Pl. XV, with the isobar-maps. We shall find, on the meridian 10⁰ W, the south side of the Jan-Mayen Channel filled with comparatively cold water, whereas the north side, under the influence of the pressure-maximum in lat. 70⁰ N, has warmer water, with a downward motion. North of Jan Mayen occurs a minimum of pressure. Here, the isotherms of the deep rise upwards.

Hence the maxima of pressure are always accompanied by downward motions of warmer and salter water, the minima of pressure by upward motions of colder water, having a less amount of salt. This accords with the fact, that the temperature of the sea is highest in the upper strata and lowest in the deeper. In the atmosphere the reverse is the case. There, accordingly, the barometric minima are accompanied by ascending currents of warmer and moister air, the barometric maxima by descending currents of colder and drier air. From the surface of the earth, heated as it is by the rays of the sun, the warm currents issue alike in the atmosphere and in the sea.

The meridional sections XXVIII, XXIX, and XXX show us that the isotherms in the upper strata, both those at 500 and those at 300 fathoms, as a rule follow the bends which these lines are found to make in the deeper strata. Note particularly the downward bend of the isotherms from the 70th to the 71st parallel of latitude, the upward bend from the 73rd to the 75th parallel, and the downward bend from parallel 76 to parallel 77, especially throughout the section extending along the meridian of Greenwich. The amount of salt (Pl. XXXVIII) exhib-

Meridiansnittet XXVIII, Pl. XLI, der viser Tæthedens Fordeling, er særdeles oplysende med Hensyn til Motivet for de opstigende og nedstigende Bevægelser.

Under 64⁰ Bredde have vi et Maximum af Tæthed og Maximum af Tryk. Det tungeste Vand synker ned gjennem det mindre tunge.

Under 68⁰ Bredde have vi et Minimum af Tæthed. Her, hvor ogsaa Trykket har sit Minimum, stiger det lettere Vand tilvejrs.

Under 70⁰ Bredde have vi et Maximum af Tæthed, og der er et Maximum af Tryk. Det tungere Vand synker ned, omgivet af lettere.

Under 74⁰ til 75⁰ Bredde have vi et Minimum af Tæthed. Her er, ved Trykkets Minimum, det lettere Vand i Opstigning.

Og under 76⁰ til 77⁰ Bredde have vi et Maximum af Tæthed, et Maximum af Tryk og det tungere Vand synkende nedad.

Sammenligne vi dernæst Tversnittene, der vise Temperaturens, Saltholdighedens og Tæthedens Fordeling tvers paa Meridianerne, med Trykkenes Fordeling i de dybere Lag, saa er følgende at bemerke.

I Tversnit X kommer paa Vestsiden koldt og noget mindre salt Vand ned fra Jan Mayen Renden. Paa Østsiden drages det kolde Bundvand opad langs Bundens Skraaning, henimod Trykminimet under 68⁰ Bredde. I Midten udøver Dybets Trykmaximum sin nedadførende Virkning paa Temperatur og Saltholdighed.

I Tversnit XIII se vi paa vestre Side Virkningen af Vandet fra Jan Mayen Renden, der er varmest og saltest ved selve Jan Mayen-Banken. Paa Østsiden løfte Isothermerne og Isosalinerne sig under Indflydelse af Trykkets Minimum under 68⁰ Bredde. Tæthedernes Fordeling her (Pl. XXXIX) give Billedet af opstigende Bobler af lettere Vand.

I Tversnit XV sees Virkningen af Trykkets Maximum i Isothermernes og Isosalinernes Sænkning mod Dybet. Under Jan Mayen, hvor det er Polarstrømmens kolde Vand, der er i Synkende under Trykmaximum, frembringes Kuldegrader fra øverst til nederst. Det tætteste Vand befinder sig i Midten af Snittet mellem Jan Mayen og Norge.

I Tversnit XVII se vi Isothermerne mellem Meridianerne 5⁰ W og 5⁰ E løfte sig under Trykkets Minimum. Vestenfor ligger Polarvandets kolde og saltfattigere Lag. Østenfor ligger varmere og saltholdigere Vand, med nedstigende Tendents, under et Trykmaximum med absolut Tæthedsmaximum.

its similar relations. Hence, the stronger vertical motions in the deep produce corresponding vertical motions in the upper strata.

The meridional section XXVIII, Pl. XLI, showing the distribution of density, is remarkably elucidative as regards the cause of the upward and downward motions.

In lat. 64⁰ N, we have a maximum of density and a maximum of pressure. The heaviest water sinks through the lightest.

In lat. 68⁰ N, we have a minimum of density. Here, where the pressure too has its minimum, the lighter water ascends.

In lat. 70⁰ N, we have a maximum of density, in conjunction with a maximum of pressure. The heavier water sinks, surrounded by lighter.

In lat. 74⁰ to 75⁰ N, we have a minimum of density. Here, at the minimum-pressure, the lighter water is rising.

And from lat. 76⁰ to 77⁰ N, we have likewise a maximum of density and a maximum of pressure, with the heavier water sinking down.

Now, if we next compare the transverse sections, showing the distribution of the temperature, the amount of salt, and the density across the meridians, with the maps showing the distribution of pressure in the deeper strata, the following remarks are called for.

In Transverse Section X, water both cold and containing a somewhat less proportion of salt flows down from the Jan-Mayen Channel. On the east side, the cold bottom-water is drawn up along the slope of the bed towards the pressure-minimum, lat. 68⁰ N. In the middle, the maximum of pressure in the deep exerts its downward effect on the temperature and amount of salt.

In Transverse Section XIII, we observe on the west side the effect of the water from the Jan-Mayen Channel, which is warmest and saltest on the Jan-Mayen Bank itself. On the east side, the isotherms and the lines of equal specific gravity rise under the influence of the minimum-pressure lat. 68⁰ N. The distribution of density here (Pl. XXXIX) shows, so to speak, ascending bubbles of lighter water.

In Transverse Section XV, we see the effect of the maximum-pressure in the descent of the isotherms and the lines of equal specific gravity towards the deep. Off Jan-Mayen, where the cold water of the Polar current sinks, acted on by the pressure-maximum, degrees below zero occur from the surface to the bottom. The water of greatest density occupies the mid-part of the section, between Jan Mayen and Norway.

In Transverse Section XVII, the isotherms between the meridians 5⁰ W and 5⁰ E are seen to rise from the action of the minimum-pressure. Farther west, extend the cold strata of the Polar current, containing a less amount of salt. Farther east, there is warmer water, richer in salt, having a downward tendency, caused by a pressure-maximum along with an absolute density-maximum.

I Tversnit XIX se* vi disse Forhold igjen. Ved Bækkenets østlige Skraaning, hvor Trykket er mindst, se vi Bundvandet stige op med lavere Temperatur og Saltholdighed.

I Tversnittene XXII, XXIII, XXIV og XXV iagttage vi fremdeles, hvorledes det samme Trykkets Maximum sender koldt Polarvand ned i Dybet. Ved Spidsbergens Banker ligger Tæthedsmaxima med synkende varmere og saltere Vand.

Vi have saaledes i vort Nordhav to Trykmaxima, der sende koldt, paa Overfladen afkjølet, og ved Issmeltning fortyndet Vand, Polarvand, fra Polarstrømmen i Grønlandshavet og ved Jan Mayen, ned i Bækkenets dybe Partier. Vi have andre Trykmaxima, ved Bækkenets Sydrand og under 70° Bredde ved dets Østrand, der sende varmere og saltere Vand ned i Dybet. Vi have Trykminima, i 68° og i 74° Bredde, der bringe det koldere og saltfattigere Dybvand op imod Overfladen. Disse forskjellige Strømninger ville, paa Grændserne mellem dem, paavirke hverandres Vandmasser ved Afkjøling eller Opvarmning, ved Udspædning eller Saltning. Men saalænge Strømmene bestaa, blive deres iboende Egenskaber vedligeholdt i den Udstrækning, Iagttagelserne vise, og med den Virkning til at holde Strømningerne vedlige, som Trykfordelingen antyder.

Efter at have studeret de verticale Bevægelser i Nordhavets Dyb kunne vi nu gaa over til at granske de horizontale Bevægelser i Niveaufladerne i de forskjellige Dybder. Overfladens Strømninger have vi allerede tidligere studeret og paavist deres Forbindelse med Temperaturens og Saltholdighedens Fordeling.

I 300 Favnes Dyb have vi et Minimum af Tryk i en Strækning fra Sydvest mod Nordost mellem Jan Mayen og Norge (Pl. XLIV). Denne Trykfordeling betinger en cyclonisk Bevægelse omkring Minimum. Paa Østsiden bliver Strømmen nordgaaende, paa Vestsiden sydgaaende. Den første fører Vand ind fra Atlanterhavet, den sidste fra Polarhavet. Trykkets Minimum ligger ikke centralt i Havet. Polarstrømmens Omraade bliver større end den atlantiske Strøms. Men Kartet Pl. XLIV viser, at ialfald den største Del af det under Grønlands Østkyst fra det indre Polarhav indstrømmende Vand finder sit Afløb gjennem Danmarkstrædet i Lagene mellem Overfladen og 300 Favnes Dyb, som er Strædets mindste Dybde. Herved afgrændses den vestligste Del af Polarstrømmen fra Circulationen i Nordhavet, og denne kan foregaa omkring et nogenlunde centralt Trykminimum.

Langs Nordsøbanken og de norske Kystbanker ligge Isobarerne for det meste paa skraa mod Isobathen for 300 Favne. I det væsentlige maa Bevægelsen nordover foregaa langs Isobathen. Hvor Trykket langs denne er aftagende, kan man vente en opstigende Bevægelse, altsaa med Temperaturforringelse; hvor Trykket er voxende, en nedstigende Bevægelse med Temperaturstigning. Saadant se vi virkelig

In Transverse Section XIX, we again meet with these conditions. On the eastern declivity of the basin, where the pressure is least, the bottom-water is seen to rise, with a lower temperature and a less amount of salt.

In Transverse Sections XXII, XXIII, XXIV, and XXV, we observe the same maximum of pressure, sending down cold Polar water into the deep. On the Spitzbergen banks occur density-maxima, with sinking water, warmer and salter.

We have thus in our North Ocean two pressure-maxima sending down cold water, cooled at the surface and diluted by the melting of ice — Polar water — from the Polar current in the Greenland Sea and off Jan Mayen, into the deep parts of the basin. Other pressure-maxima occur, at the southern margin of the basin and, in lat. 70° N, at its eastern margin, that send down warmer and salter water into the deep. We have pressure-minima in lat. 68° and 74° N, bringing up the water of the deep, colder and less salt, towards the surface. These different currents will act at their several limits on the mass of each other's water, by cooling or by heating, by diluting or by increasing the amount of salt. But, as long as the currents exist, their inherent characteristics are maintained to the extent shown by the observations, together with the effect to maintain the currents indicated by the distribution of pressure.

Heaving studied the vertical motions in the deep of the North Ocean, we can now pass on to examine the horizontal motions at the surfaces of level at the several depths. The currents of the surface we have previously investigated, and shown their connexion with the distribution of temperature and the proportion of salt.

At a depth of 300 fathoms, we have a minimum of pressure throughout a tract stretching from south-west to north-east, between Jan Mayen and Norway (Pl. XLIV). This distribution of pressure determines a cyclonic motion around the minimum. On the east side, the current sets northward, on the west southward. The former branch carries in water from the Atlantic Ocean, the latter from the Polar Sea. The minimum of pressure does not occupy a central position in the sea. The area of the Polar current exceeds that of the Atlantic current. But the map Pl. XLIV shows that at all events the greater part of the water flowing in along the east coast of Greenland from the inner tracts of the Polar Sea, has its outlet through Denmark Strait in the layers between the surface and 300 fathoms beneath, the least depth in the Strait. Thus the western part of the Polar current is bounded off from the circulation of the North Ocean, and this can take place round a comparatively central pressure-minimum.

Along the North-Sea Bank and the Norwegian Coast Banks, the isobars have in great part an oblique position towards the isobath for 300 fathoms. The motion northward must chiefly proceed along the isobath. Wherever the pressure along the isobath is found to decrease, an upward tendency may be expected, accordingly with a diminution of temperature; where the pressure is found to

er Tilfældet (Pl. XIX). Under 60° Br. ved Wyville Thomson-Ryggen er Maximum af Tryk og et Temperaturmaximum paa over 5°. Ved Spidsen vestenfor Stad er kun 2°, i Indbugtningen udenfor Romsdalen med det høje Tryk er 5°, under 66°—67° Br. er kun 3°, men udenfor Lofoten og Vesteraalen, hvor Trykket i Indbugtningen er højt, er mellem 5° og 4°. I Indbugtningen Syd for Beeren Eiland, hvor Trykket har et Minimum, er et Temperaturminimum af under 1°. Langs Spidsbergbanken, hvor den horizontale Bevægelse maatte foregaa tildels mod stigende Tryk, sker den i Virkeligheden langs Isobarerne med Nedstigning over Banken og højere Temperatur. Man sammenligne med Profilet Pl. XXVI, der viser disse Isothermernes op- og nedgaaende Bøjninger ved 300 Favnes Dybde.

Wyville Thomson-Ryggens Dybde er omkring 300 Favne. Over denne Ryg strømmer det varme og salte atlantiske Vand ind i Nordhavet, drevet af Tryk, der repræsenteres, som vi have seet, ved Vindfladen, mod Nordost indover Færø-Shetland-Renden. Men denne er 600 Favne dyb. Det varme Vand drives hovedsagelig henimod Rendens sydøstlige Bred. Dets Underflade slæber en Del Vand med sig fra de dybere Lag. Dette erstattes derved, at der i de underste Lag strømmer Vand ind langs Rendens Bund fra Nordhavsbækkenet, og langs Rendens nordvestre Bred — Færøbanken — imod det statiske Tryk. Virkningen heraf se vi i Temperaturens Fordeling. Iskoldt Vand dækker Rendens Bund helt op til 300 Favnes Dyb, og iskoldt Vand løfter sig langs Færøbanken til et endnu højere Niveau. (Profil VI, Pl. IX). Endvidere: Vandets Bevægelse langs den sydøstre Bred mod aftagende Tryk løfter det op, og Isothermen for —1° i dette Profil bøjer sig op mod begge Sider, sænker sig ned i Midten. Hertil kan ogsaa den Omstændighed bidrage, at Vandets Bevægelse i de højere Lag foregaar med en større Hastighed end i de dybere. Det hurtigere løbende Vand river det langsommere med sig, og dette maa erstattes — tomme Rum kunne ikke existere — fra neden. De her forklarede Principer for denne Art Reactionsvirkning, der oprindelig ere fremsatte af Professor Ekman i Stockholm, finde jevnlig Anvendelse i den følgende Redegjørelse. En Bevægelse mod mindre Tryk, altsaa under en Vinkel med Gradienten, der er mindre end en ret, vil have tilfølge — under uforandret Friction — en større Hastighed, og en raskere Bevægelse opad. Den større horizontale Hastighed fremkalder ogsaa en raskere Sugning af de dybere Lag opad.

Det Vand, som Polarstrømmen ikke sender ud gjennem Danmarkstrædet, faar sit Afløb gjennem Jan Mayen-Renden, langs Islandsbanken, Island-Færø-Ryggen og Færøbanken. I 300 Favnes Dyb kan dette Vand bevæge sig temmelig nær paa normal cyclonisk Maade. Efter sin Op-

increase, a downward tendency, with an increase of temperature. And such we see is actually the case (Pl. XIX). In lat. 60° N, at the Wyville-Thomson Ridge, occurs a maximum of pressure and a temperature-maximum of more than 5°. At the salient point west of Stad, there is only 2°; in the recess off Romsdalen, with the high pressure, the temperature reaches 5°; in lat. 66° to 67° N, it is only 3°; but off Lofoten and Vesteraalen, where the pressure in the recess is considerable, it reaches between 5° and 4°. In the recess south of Beeren Eiland, where the pressure has a minimum, there is a temperature-minimum of less than 1°. Along the Spitzbergen Bank, where the horizontal motion should in part proceed against the pressure, it really follows the isobars, with a descent across the bank and a higher temperature. Compare with the profile Pl. XXVI, that shows these upward and downward bends of the isotherms in a depth of 300 fathoms.

The depth of the Wyville-Thomson Ridge reaches about 300 fathoms. Over this ridge, flows into the North Ocean the warm and salt water of the Atlantic, impelled by pressure — which, as we have seen, is represented by the wind-surface — towards the north-east, along the Færoe-Shetland Channel. But this channel is 600 fathoms deep. The warm water is carried chiefly towards the south-easterly border of the channel. Its under surface carries along with it water from the lower depths. This is compensated by water pouring along the bottom of the channel in the deepest strata from the basin of the North Ocean, and also along the north-western border of the channel — the Færoe Bank — against the static pressure. The effect of this is seen in the distribution of temperature. Ice-cold water covers the bottom of the channel as high up as 300 fathoms, and ice-cold water rises along the Færoe Bank to a still higher level (Profile VI, Pl. IX). Moreover, the motion along the south-eastern margin with diminishing pressure raises the water, and the isotherm for —1° in this profile rises towards either side and sinks in the middle. Possibly this is brought about in part by the motion of the water in the higher strata having a greater velocity than in the deeper. The water running with greater velocity carries along with it that flowing at a slower rate, and this has to be compensated — a vacuum cannot exist — from below. The principles, expounded here, on which I base this kind of reaction (they were originally set forth by Professor Ekman in Stockholm) meet with frequent application in the following explanatory statement. A motion with decreasing pressure, or at an angle with the gradient less than a right angle, will be attended with the result — friction unchanged — of greater velocity and a more rapid upward motion. The greater horizontal velocity will also occasion more rapid suction upwards of the deeper strata.

The water which the Polar current does not discharge by way of Denmark Strait, it sends through the Jan-Mayen Channel, along the Iceland Bank, the Iceland-Færoe Ridge, and the Færoe Bank. At a depth of 300 fathoms, this water can move very nearly in a normal cyclonic manner.

rindelse er det iskoldt Vand, og det vedligeholder denne Character helt til henimod Norges Banker. Det opvarmes noget paa Vejen, fra oven og fra begge Sider, af det varme Vand, der strømmer over Island-Færø-Ryggen, og af det varmere Vand mellem Jan Mayen og Norge.

Udenfor Lofoten og Vesteraalen gjør den nedstigende Bevægelse i de dybere Lag sig gjældende ogsaa i 300 Favnes Dyb. Det nordover strømmende varme Vand drages vestover og nedover henimod Jan Mayen, som Temperaturkartet Pl. XIX viser. Det sætter altsaa tvers over det bariske Minimum i denne Dybde.

Kommen vestenfor Greenwich Meridian bøjer Isobarernes Retning Bevægelsen mod Syd. Dette er udtrykt ved den varme Tunge paa over 2° i Sydost for Jan Mayen. Vestenfor denne slutter Bevægelsen af det ombøjede varme Vand sig til det kolde Vand fra Jan Mayen Renden, som det ledsager, med indbyrdes Opvarmning og Afkjøling, i dets cycloniske Bevægelse søndenom det bariske Minimum og videre østover og nordover.

Østenfor Tungen for 2° ligger et thermisk Minimum paa 1°.1. Det er Virkningen af den opstigende kolde Strøm, der existerer i Dybet paa dette Strøg.

I Polarstrømmen spore vi den afkjølende Virkning fra neden af Trykminimet paa 73° til 74° Br. mellem 0° og 5° E. Lgd. i den lave Temperatur paa under —1°, som den sydsydvestgaaende Strøm her paa dette Strøg faar.

Paa Østsiden af Jan Mayens Banke løber Polarstrømmen med en betydelig Fart, og bringer Kuldegraderne i en Tunge sydover, vistnok tildels ved Sugning fra Dybet. Paa Vestsiden af Banken maa Vandet bevæge sig, suget rundt dens Sydpynt af den paa Nordvestsiden løbende Strøm, imod Nordvest, imod Trykket, for senere at bøje om i Følge med Strømmen i Jan Mayens Rendens Hoveddel. Denne Ombøjning af Strømmen i Læ af en Kyst eller Banke er analog med Vindens Virkning paa Vandet ved Spidsbergens Vestkyst. Virkningen beror naturligvis paa Bankens Form og Stilling mod den herskende Strøm. Bankens Form er i det foreliggende Tilfælde for en Del hypothetisk (Side 4), men Reactionens Virkning se vi i den forholdsvis varme Tunge, der skyder op paa Bankens Vestside. Vi gjenfinde denne Tunge i de større Dyb og se den i 1000 Favnes Dyb ogsaa motiveret ved det herværende Trykmaximum.

Paa Karterne har jeg søgt at antyde Bevægelsens Retning ved Pile. Hvor Bevægelsen har en opstigende Component, har Pilen et Punkt i Enden; hvor den har en nedstigende Component, har Pilen en Ring i Enden.

Bevægelsens Hastighed i 300 Favnes Dyb kan vistnok for en stor Del af Havet beregnes efter Formelen Side 176, naar man sætter Afbøjningsvinkelen $\alpha = 90°$, nemlig paa de Steder, hvor Bevægelsen foregaar parallel med Isobarerne. Hvor Bevægelsen gaar i en Retning, der danner

Originally ice-cold water, it retains this character to well-nigh the Norwegian banks. It gets slightly warmed on its course, from above and from both sides, by the warm water flowing over the Iceland-Færoe Ridge, and by the warm water that passes between Jan Mayen and Norway.

Off Lofoten and Vesteraalen, the downward motion in the deeper strata makes its influence felt also at a depth of 300 fathoms. The warm water flowing north is drawn westward and downward, in the direction of Jan Mayen, as appears from the Map of Temperature, Pl. XIX. Hence, it crosses the baric minimum at that depth.

West of the meridian of Greenwich, the direction of the isobars turns the motion towards the south. This has its thermic expression in the warm tongue of water, of a temperature exceeding 2°, south-east of Jan Mayen. West of this tongue, the motion of the warm water, turned aside as stated above, joins the cold water from the Jan-Mayen Channel, which it accompanies, with reciprocal cooling and warming, in its cyclonic motion south of the baric minimum, and farther on towards the east and north.

To the east of the tongue for 2°, we observe a thermic minimum of 1°.1. It results from the ascending cold current, present in the deep throughout this tract.

In the Polar current, we trace the cooling effect from below of the pressure-minimum, lat. 73° to lat. 74° N, between long. 0° and 5° E, in the low temperature, less than —1°, which the current setting south-south-west exhibits here.

On the east side of the Jan-Mayen Bank, the Polar current runs with considerable velocity, and carries the temperatures below zero as a tongue southward, aided no doubt by suction from the deep. On the west side of the bank, the water must move, drawn round its southern extremity by the current flowing on the north-west side, towards the north-west, against the pressure, to bend round subsequently, along with the current in the main part of the Jan-Mayen Channel. This bending-round of the current under the lee of a coast or a bank is analogous to the action of the wind on the water off the west coast of Spitzbergen. The effect depends of course on the form and position of the bank relative to the prevailing current. The form of the bank in the present case is partly hypothetical (p. 4); but the effect of the reaction may be seen in the comparatively warm tongue that shoots up on the west side of the bank. We again meet with this tongue in the greater depths, and observe it at a depth of 1000 fathoms, also as the result of the pressure-maximum occuring there.

On the maps I have sought to indicate the direction of the motion by means of arrows. Where the motion has an ascending component, the arrow exhibits a dot at the end; where it has a descending component, the arrow exhibits a ring at the end.

The velocity of the motion at a depth of 300 fathoms may, it is true, for a great part of the sea, be computed according to the formula p. 176, putting the angle of deflection $\alpha = 90°$, viz., at places where the motion proceeds parallel with the isobars. Where the motion proceeds in

en spids Vinkel α med Gradienten, skulde man regne med Formelen

$$u = 10.333 \frac{g_{45}}{S} \cdot \frac{\triangle p^{at}}{\triangle x^{m}} \cdot \frac{\cos \alpha}{k} \,.$$

I dette Tilfælde vil Bevægelsen kunne blive accelererende. Men det er at merke, at den for en Del er opstigende, modvirkes altsaa af Tyngden. I det Tilfælde, at Bevægelsen foregaar paa skraa mod Isobarerne, fra det lavere mod det højere Tryk, vil den kunne blive retarderende, men her har den en nedstigende Component og understøttes saaledes af Tyngden. Endvidere sees, at de forskjellige Slags Bevægelser langs Isobathen jevnlig afvexle hverandre, og Vandets Continuitet vil regulere Bevægelsen saaledes, at den ogsaa her nærmer sig til at blive continuerlig og overensstemmende med den, der følger af Formelen Side 176 med $\alpha = 90^0$.

Isobarsystemet for 300 Favnes Dyb er væsentlig det samme som Vindfladens. Vi faa saaledes i dette Dyb den samme Fordeling af Hastighederne, som er beskrevet under Vindfladens Beskrivelse. Værdien af Gradienten for Afstanden mellem to Isobarer er den samme i begge Tilfælder. Den Omstændighed, at Vandet i 300 Favnes Dyb er noget tungere end i Overfladen, gjør Hastighederne i Dybet forholdsvis mindre, dog kun i Forholdet 1.027 : 1.030 eller 0.9971, det er 0.3 Procent mindre. Man kan derfor godt benytte Skalaen paa Pl. XLIII til at udmaale Hastighederne.

Ved at sammenligne Karterne Pl. XLIII og Pl. XLIV ser man, at Strømhastighederne i Overfladen ere ideththeletaget betydelig større end i 300 Favnes Dyb. Forskjellen er netop de Hastigheder, der svare til Tæthedsfladen. Thi Vindfladens Ordinater Pl. XXXIII og XLIV ere Strømfladens (Pl. XLIII) minus Tæthedsfladens (Pl. XLII).

Der, hvor Vandet i 300 Favnes Dyb passerer over Wyville Thomson-Ryggen, angiver Kartet en Hastighed af 0.1 m. p. S. (5 Kvm. i 24^h, 0.21 Kvm. i 1^h). D. Stevenson angiver,[1] at en Hastighed af Strømmen i en Elv af 3 Tommer pr. Secund (0.170 Mil pr. Time) vil netop begynde at virke paa fint Ler, medens en Hastighed af 6 Tommer pr. Secund (0.34 Mil pr. Time) vil løfte fint Sand. Mellem disse Hastigheder ligger den af mig beregnede Strømhastighed. Denne skulde saaledes være tilstrækkelig til at transportere lettere Bundmateriale fra Ryggen ind i Færø-Shetland-Renden. J. Murray siger[2]: "At der over Ryggen stryger saavel sterke Tidevandsstrømme som den stadige Strøm mod Nordost, fremgaar af den Omstændighed, at ingen Aflagring af fint Material faar Lov til at lægge sig paa den, og af de Sandkorn og Smaastene, der ere spredte over Havbunden imod Nordost. Over Ryggen viser

[1] A. Geikie, Text-Book of Geology, 1882. S. 368.

[2] Encyclopædia Britannica S. 594.

a direction forming an acute angle, α, with the gradient, the computation should be made with the formula

$$u = 10.333 \frac{g_{45}}{S} \cdot \frac{\triangle p^{at}}{\triangle x^{m}} \cdot \frac{\cos \alpha}{k} \,.$$

In this case the motion can become accelerated. Meanwhile, we must bear in mind that to some extent it is ascending, and therefore counteracted by gravity. Should the motion proceed obliquely to the isobars, from the lower to the higher pressure, it may become retarded, but then it has a descending component, and is thus assisted by gravity. Moreover, it appears that the different kinds of motion proceeding along the isobath continually vary, and the continuity of the water will regulate the motion, so that here too it shall tend to become continuous, and to accord with that resulting from the formula, p. 176, with $\alpha = 90^0$.

The isobar-system, for a depth of 300 fathoms, is in all essential particulars the same as that of the wind-surface. Hence, at this depth we get the same distribution of velocity as set forth in the description of the wind-surface. The value of the gradient for the distance between any two isobars is the same in either case. The circumstance, that at a depth of 300 fathoms the water is somewhat heavier than at the surface, entails in the deep comparatively reduced velocities — but only in the ratio of 1.027 : 1.030 or 0.9971, i. e., 0.3 per cent less. We may therefore, without apprehension, make use of the scale given in Pl. XLIII for measuring the velocity.

If we compare the maps Pl. XLIII and Pl. XLIV, it will appear that the current-velocities at the surface, taken on the whole, are considerably greater than at a depth of 300 fathoms. The difference applies exclusively to the velocities resulting from the surface of density. For the ordinates of the wind-surface (Pl. XXXIII and Pl. XLIV) are those of the current-surface (Pl. XLIII) minus those of the surface of density (Pl. XLII).

Where, at a depth of 300 fathoms, the water passes over the Wyville-Thomson Ridge, the map gives a velocity of 0.1 m. per sec. (5 naut. miles in 24 hours = 0.21 naut. mile in 1 hour). Mr. D. Stevenson states[1] that a river-current with a velocity of 3 inches per second (0.170 mile an hour) will just begin to work on fine clay, whereas a velocity of 6 inches per second (0.34 mile an hour) will lift fine sand. Between these two velocities lies the current-velocity I have computed. The latter should accordingly be sufficient to transport lighter bottom-materials from off the ridge into the Færoe-Shetland Channel. Mr. J. Murray says:[2] — "That the Wyville-Thomson Ridge is swept by strong tidal currents as well as by the steady flow to the north-east is shown by the fact that no fine deposit is allowed to accumulate on it, and by the particles of sand and gravel from the ridge which are spread over the sea-bottom

[1] A. Geikie, Text-Book of Geology, 1882, p. 368.

[2] Encyclopædia Britannica, p. 594.

der sig store „Bleker" og Opkommer af Vand til visse Tider, naar den store Flodbølge passerer gjennem denne Rende mod Nordost. Bergarter fra Ryggen ere, i Smaastykker, meget talrigere og større i det iskolde end i det varme Strøg, og de pege saaledes paa den Retning, i hvilken Strømningerne feje Bunden. De større Stene ligne Bergarterne fra Orkenøerne".

Langs Norges Kystbanker tør Hastigheden af Strømmen i 300 Favnes Dyb gaa op til 0.12 m. p. S. (5 à 6 Kvm. i 24 h), i Polarstrømmen ved Jan Mayen til 0.16 m. p. S. (7 à 8 Kvm.), under Grønland til 0.08 m. p. S. (4 à 5 Kvm.). I den centrale Del ere Hastighederne meget ringe.

Efter at have studeret Bevægelserne i 300 Favnes Dyb kunne vi nu med fuldere Forstaaelse gaa over til at betragte Bevægelserne i de Dybder, der ligge mellem denne Niveauflade og Overfladen.

I de øverste Vandlag fylder Strømmen fra Atlanterhavet nordenom Skotland Nordsøen. Den bringer det salte Vand fra Oceanet ind over Nordsøens Flak (Pl. XXXV) og fylder den norske Rendes Dyb[1] med ægte salt Atlanterhavsvand. I den sydlige Del af Nordsøen er Vandet mere opspædet af Elvene, navnlig i de øvre Lag.

I 100 Favnes Dyb (Pl. XVII) se vi Virkningen af den nordgaaende varme Strøm langs Nordsøbanken og Norges Kystbanker. I Færø-Shetland Renden suges aabenbart Vand langs den nordre Bred sydover fra det norske Hav. Langs Norges Banker gjør endnu Landkulden sig gjældende. Varmetungerne ligge løsrevne fra Banken med koldere Vand imellem begge.

I Østhavet driver Strømmen varmt Vand ind til omtrent Midten af Havet i 100 Favnes Dyb. I dets østlige og nordlige Del formaa Vindene og Tæthederne ikke at føre Vandmassen i dens hele Mægtighed med. Bunden er dækket af iskoldt Vand fra Havets nordlige Del. Dette Vands øvre Lag rives med af Overfladestrømmen, og maa erstattes af Vand, der langs Bunden finder sin Vej nordenfra, fra Egne, hvor Havets Vand altid har en lav Temperatur gjennem hele sin Dybde.

Den kolde Storfjord paa Spidsbergen sender koldt Vand ned i den Indbugtning, som Banken har østenfor Sydkap. Paa Vest-Spidsbergens Banker se vi i 100 Favnes Dyb Landkuldens Virkning.

I den grønlandske Polarstrøm gjenfinde vi den afkjølende Virkning af Dybets Trykminimum under 73°—74° Bredde og Strømningerne omkring Jan Mayens Banke.

[1] Pommerania Expeditionen 1872.

to the north-east. Over the ridge large smooths and wellings up of water take place at certain times as the great tidal wave passes through this channel into the North Sea. Mineral particles from the ridge are much more numerous and larger in the cold than in the warm area, thus indicating the direction in which the currents sweep. The stones resemble those of the Orkneys."

Along the coast banks of Norway, the velocity of the current at a depth of 300 fathoms may reach 0.12 m. per sec. (5 or 6 naut. miles in 24 hours); the velocity of the Polar current off Jan Mayen, 0.16 m. per sec. (7 or 8 naut. miles), off the coast of Greenland 0.08 m. per sec. (4 or 5 naut. miles). In the central part the velocities are very trifling.

Heaving investigated the motion at a depth of 300 fathoms, we can now with fuller comprehension pass on to consider those in the depths between that level and the surface.

In the upper strata, the current from the Atlantic north of Scotland fills the North Sea. It brings with it the salt water from that ocean over the flat of the North Sea (Pl. XXXV), and fills the deep of the Norwegian Channel[1] with genuine salt Atlantic water. In the south part of the North Sea, the water is more diluted with the outflow of the rivers, more especially throughout the upper strata.

At a depth of 100 fathoms (Pl. XVII), we see the effect of the warm current setting north along the North-Sea bank and the Coast Banks of Norway. In the Færoe-Shetland Channel, water is manifestly drawn south by suction along the northern margin from the Norwegian Sea. Along the Norwegian banks, the land-cold still asserts its influence: the tongues of heat lie quite isolated from the bank, with colder water intervening.

In the Barents Sea the current forces in the warm water to well-nigh the middle of that tract of ocean, at the depth of 100 fathoms. In its eastern and northern parts, the winds and the densities combined are unable to carry along the water in its entire depth. The bottom is covered with ice-cold water from the northern part of the sea. The upper stratum of this water is carried along with the surface-current, and has to be compensated by water which finds along the bottom its way southward from regions where the water of the sea has always a low temperature throughout its entire depth.

The Storfjord, Spitzbergen, sends down its cold water into the recess which the bank exhibits east of South Cape. On the banks of West Spitzbergen, we perceive at a depth of 100 fathoms the effect of the land-cold.

In the Greenland Polar current, we again fall in with the cooling influence resulting from the pressure-minimum of the deep in lat. 73°—74° N and the currents flowing round the banks of Jan Mayen.

[1] The Pommerania Expedition 1872.

I Jan Mayen Renden skyder sig i alle Dybder en kold Tunge ned østenfor Island.

Over Islands Banker strømmer varmt Vand i anticyclonisk Retning.

Mellem Island og Færøerne føres i den sydlige Del atlantisk Vand over til det norske Hav. I den vestlige Del af dette Strøg strømmer Atlanterhavets Vand nordover og vestover. Denne Strøm har paa sin højre Side Tungen fra Jan Mayen Renden (Tversnit V, Pl. IX), hvis Vand strømmer sydover. I de øverste Lag skylle Vindene den sidstes koldere Vand udover den førstes varmere. I de dybere Lag trænger den varmere Strøm frem under den koldere, idet den følger Bankens Indbøjninger.

Dybets Trykmaximum i Station 52, østenfor Island, gjør sig gjældende ogsaa i de øvre Lag. Der synes at foregaa en Sugning af varmt Vand østenfra derhenimod.

I 200 Favnes Dyb gjenfinde vi de ovenfor beskrevne Træk i det hele taget. Kun de enkelte nye behøve derfor her at beskrives.

Landkuldens Virkning er ophørt. Det varmeste Vand ligger paa Havets Østside lige ved Bankerne. Under 66° 40′ N. Br., 7°—8° E. Lgd. gjør Isobathen for 200 Favne en pludselig Bøjning mod Øst. Ligesaa i 300 Favnes Dyb. Som Pl. XLIV viser, føres her Vandet tvers udover Banken, med nedstigende Tendens. Det er omtrent lignende Tilfælde som paa Wyville Thomson-Ryggen. Idet Vandet i sin nordgaaende Bevægelse forlader Banken, fører det det nærmeste Underlag med sig. Dette erstattes nedenfra, og koldere Vand suges saaledes ind over Banken. Man ser dette i Karterne Pl. XVIII og XIX, i Tversnit XII, Pl. X, i Profilet Pl. XXVI, og i Bundtemperaturkartet Pl. XXV, hvor Isothermerne for 5° og 6° have betydelige Indsænkninger mod Syd.

Den tidligere Side 68 beskrevne kolde Bundstrøm fra Storfjorden nedover Spidsbergbanken træder frem i 200 og 300 Favnes Dyb, og sees bedst paa Bundkartet Pl. XXV. Dens Motiv finde vi i Trykfordelingen, Pl. XLIII, der giver en Gradient directe ud af Storfjorden i Retning af det iskolde Vands Bevægelse.

Af Tversnittene og Karterne fremgaar det, at det varme Vand paa Kystbankerne af disse beskyttes mod Afkjøling fra neden, i Modsætning til den sterke Afkjøling, som finder Sted der, hvor varmt og iskoldt Vand grændse ind til hverandre, som østenfor Jan Mayen, paa Island-Færø-Ryggen (her i horizontal Retning), Færø-Shetland-Renden, paa Yderskraaningen af de norske Banker, med flere Steder. I Overfladen har Strømmen sin største Hastighed. Den aftager nedover til 300 Favnes Dyb.

I 500 Favnes Dyb (Pl. XLV) er Isobarsystemet meget ligt det i 300 Favne. Nordhavet er ganske afspærret

In the Jan-Mayen Channel, a cold tongue shoots down in all depths east of Iceland.

Over the banks of Iceland, warm water flows in an anticyclonic direction.

Between Iceland and the Færoes, in the southern part of this tract, Atlantic water is carried over to the Norwegian Sea. In the western part water from the Atlantic flows northward and westward. On its right side, this current has the tongue from the Jan-Mayen Channel (Transverse Section V, Pl. IX), whose water sets southward. Throughout the uppermost strata, the winds sweep the colder water of the latter over the warmer water of the former. In the deeper strata, the warmer current forces its way under the colder, following, as it does so, the sinuosities of the bank.

The pressure-maximum of the deep at Station 52, east of Iceland, asserts its influence also in the upper strata. A suction of warm water from the east, would appear to proceed towards that part.

At a depth of 200 fathoms, we again, on the whole, meet with the features described above. Hence, only the new characteristics need be set forth here.

The effect of the land-cold has ceased. The warmest water lies on the east side of the ocean, close to the banks. In lat. 66° 40′ N, long. 7° to 8° E, the isobath for 200 fathoms makes a sudden bend toward the east. The same is the case at a depth of 300 fathoms. As shown in Pl. XLIV, the water here is carried straight across and past the bank, with a downward tendency. This is much the same as on the Wyville-Thomson Ridge. As the water, when setting north, leaves the bank, it carries with it the nearest substratum. For this, compensation is given from below, colder water being drawn in over the bank. This is shown in the maps Pls. XVIII and XIX, in transverse section XII, Pl. X, in the profile, Pl. XXVI, and in the Bottom-Temperature Map, Pl. XXV, where the isotherms for 5° and 6° form distinct loops towards the south.

The cold bottom-stream, described on page 68, flowing down from the Storfjord over the Spitzbergen Bank, makes its appearance in depths of 200 and 300 fathoms, and is best seen on the Bottom-Map, Pl. XXV. Its motive we find in the distribution of pressure, Pl. XLIII, which shows a gradient pointing straight out of the Storfjord in the direction taken by the ice-cold water.

From the transverse sections and the maps, it appears that the warm water on the coast banks is protected by the latter against cooling from below, in contrast to the very considerable cooling that results where warm and ice-cold water border on each other, as for example east of Jan Mayen, on the Iceland-Færoe Ridge (there horizontally), the Færoe-Shetland Channel, on the outer slope of the Norwegian banks, as also in several other localities. At the surface, the current has its greatest velocity. This decreases downwards to a depth of 300 fathoms.

At a depth of 500 fathoms (Pl. XLV), the isobar-system resembles that at a depth of 300 fathoms.

fra Atlanterhavet, men staar i aaben Forbindelse med det indre Ishav. I Færø-Shetland Renden cirkulerer iskoldt Vand, saaledes som Pilene antyde. Udenfor Norges Vestkyst bringer den nordgaaende og opstigende Bevægelse Vand af -1^0 Temperatur op langs Banken (Pl. XXI). Omkring den 70. Breddegrad gaar det varme Vand vestover og nedover, idet det følger Draget fra de dybere Lags bariske Maximum. I Sydvest for Beeren-Eiland, hvor det bariske Minimum støder op til Banken, løfter ogsaa koldt Vand fra Dybet sig op. Langs denne Banke og Spidsbergbanken gaar, i Overensstemmelse med Isobarernes Retning, en varm Tunge nordover. Lige ved Banken suger Bevægelsen dog noget koldere Vand op langs denne. I Polarstrømmen gjenfinde vi de samme Hovedtræk i Temperaturen som i de højere liggende Lag. I Station No. 52 yttrer Dybets bariske Maximum sig ved den noget højere Temperatur i Modsætning til No. 51 og No. 53.

Strømmens Hastighed i 500 Favnes Dyb er gjennemgaaende lidt mindre end i 300 Favne. F. Ex. ved Jan Mayen 0.09 m. p. S. (4 Kvm. i 24^h). Udenfor Norge findes den samme Hastighed.

I 1000 Favnes Dyb er Trykkets Fordeling (Pl. XLVI) en ganske anden end i de højere Lag. Istedetfor et centralt Minimum have vi flere Minima og flere Maxima. Som ovenfor paapeget, komme de verticale Bevægelser her til at gjøre sig mere gjældende end i de højere Lag.

I Norskedybet læner et barisk Maximum sig til den sydlige Rand af dette. Den deraf flydende nedadstigende Bevægelse giver (Pl. XXIII) et Temperatur-Maximum. Man vil bemerke, at i dette Bækken pege Gradienterne mod Nord. Men de ere sterkere paa Østsiden end paa Vestsiden. Den horizontale Bevægelse maa derfor adlyde de første og blive nordgaaende paa Østsiden, sydgaaende paa Vestsiden, østgaaende paa Sydsiden. Paa Vestsiden, hvor Bevægelsen gaar mod Gradienten, vil den blive nedstigende. Saavel Pl. XXIII som Pl. XXV viser, at det er det kolde Vand fra Jan Mayen Renden, som her søger nedover langs Bunden. Paa Østsiden gaar Bevægelsen med Gradienten, kanske med Acceleration, og med Opstigning mod Trykkets Minimum i 68^0 Bredde. En sterk Opsugning fra neden af koldt Vand er Følgen, og samtidig dermed en Sugning af Vand langs Bækkenets Sydrand. Virkningen her er dog svagere, da Trykkets Maximum tvinger de højere Lag her nedad, og da Vandet i Dybet maa afgives for en Del til Færø-Shetland-Renden. Den fulde Virkning af Maximumstrykket kommer imidlertid først tilsyne midt i Bækkenet, hvor Isothermen for -1^0 (Tversnit X, Pl. X, Station No. 52 og Pl. XXVI) naar ned til en betydelig Dybde.

Paa 67^0 til 68^0 Bredde kan det kolde Vand fra Jan

The North Ocean is entirely cut off from the Atlantic, but in open connection with the inner tracts of the Polar Sea. In the Færoe-Shetland Channel, ice-cold water circulates, as indicated by the arrows. Off the West Coast of Norway, the northward-setting and ascending motion brings up water of -1^0 temperature along the bank (Pl. XXI). At the 70th parallel of latitude, the warm water passes west and downward, following, as it does so, the suction from the baric maximum of the deeper strata. South-west of Beeren-Eiland, where the baric minimum reaches the bank, cold water rises up from the deep. Along this bank and that of Spitzbergen, extends, in conformity with the direction of the isobars, a warm tongue northward. In immediate proximity to the bank, however, the motion draws up along it somewhat colder water. In the Polar current, as regards temperature, we observe the same principal features as in the higher-lying strata. At Station No. 52, the baric maximum of the deep asserts its influence in the somewhat higher temperature, as opposed to No. 51 and No. 53.

The velocity of the current at a depth of 500 fathoms is somewhat less on the whole than at a depth of 300 fathoms: for example, off Jan Mayen 0.09 m. per sec. (4 naut. miles in 24 hours). Off the coast of Norway, the same velocity is met with.

At a depth of 1000 fathoms, the distribution of pressure (Pl. XLVI) is totally different from that in the higher strata. Instead of a central minimum, we have several minima and several maxima. As pointed out above, the vertical motions here will be more prominent than in the higher strata.

In the Norway Deep, a baric maximum leans up to its southern margin. The downward motion proceeding thence results (Pl. XXIII) in a temperature-maximum. It will be observed that in this basin the gradients point northward. But they are steeper on the east side than on the west. Hence the horizontal motion must yield to the former, and set northward on the east side, southward on the west side, and eastward on the south side. On the west side, where the motion proceeds against the gradient, it will be downward. As well Pl. XXIII as Pl. XXV shows it to be the cold water from the Jan-Mayen Channel that here seeks a downward passage along the bottom. On the east side, the motion goes with the gradient, possibly with acceleration, and with ascension towards the minimum of pressure in lat. 68^0 N. A strong suction of cold water from below is the result, and simultaneously a suction of water along the southern margin of the basin. The effect here however is weaker, since the maximum of pressure forces downward the higher strata, and since the water of the deep must in part be given off to the Færoe-Shetland Channel. The full effect of the maximum-pressure becomes first apparent in the middle of the basin, where the isotherm for -1^0 (Transverse Section X, Pl. X, Station 52, and Pl. XXVI) reaches down to a considerable depth.

In lat. 67^0 to 68^0 N, the cold water from the Jan-

Mayen Renden og fra Trykkets Maximum østenfor Jan Mayen bevæge sig cyclonisk tvers over Bækkenet til Trykkets Minimum. Vi se Virkningen heraf i Isothermernes og Isosalinernes Opadbøjning paa dette Strøg.

I Lofotdybet har Trykket sit Maximum i den østligste Del og aftager vestover. Bevægelsen er her vestgaaende og nedstigende. Den udøver saaledes sin Maximumsvirkning (Isothermernes dybeste Punkt) desto længere vest, jo større Dybden er. Se Tversnit XV, Pl. XI. I 1000 Favnes Dyb ligger Maximumstemperaturen i en større Afstand fra Banken. I Rummet mellem begge suges, ved den vestgaaende Bevægelse, koldere Vand ind fra Dybet og fra Siderne.

Langs Banken op mod Spidsbergen gaar Bevægelsen nordover, for den største Del med aftagende Tryk og med samme Virkning som i 500 Favnes Dyb, nemlig Tunge af relativ højere Temperatur med Opsugning af koldere Vand langs Banken.

Trykkets Minimum i 74° Bredde bringer Ishavets koldeste Vand op til højere Niveauer, medens det lille Trykmaximum i 77° Bredde holder Temperaturen forholdsvis høj.

Om Hastigheden af Bevægelserne i 1000 Favnes Dyb er det vanskeligt at dømme, da de verticale Bevægelser ere saa fremtrædende. En Sammenligning mellem Isobarsystemerne i 1000 og i 500 Favnes Dyb antyder nærmest, at Hastighederne i 1000 Favnes Dyb skulde være endnu noget mindre, end i 500 Favnes.

I 1500 Favnes Dyb ere Nordhavets tvende Bassiner adskilte fra hverandre (Pl. XLVII). I det sydlige, Norske-Dybet, have vi et Isobar-, Strøm- og Temperatur-System, der ganske ligner det i 1000 Favne. Temperaturmaximum ved 71° Bredde ligger lidt vestligere, da den nedstigende Bevægelse foregaar i denne Retning. Reactionsstrømningerne under Trykmaximum i Lofotdybet ere antagelig i 1500 Favnes Dyb forholdsvis sterkt udviklede, da Bunden kun ligger lidet dybere.

I det nordre Bækken, Svenskedybet, er der ved Sydvestranden et sterkt udviklet Trykminimum, i dets nordlige Del et mindre Trykmaximum. Paa Bækkenets vestre Side ere Gradienterne sterkere end paa dets østre. Bevægelsen maa derfor gaa paa Vestsiden mod Syd og opad, paa Østsiden mod Nord og nedad. Temperaturen (Pl. XXIV) er overensstemmende hermed lavest paa Vestsiden og højest paa Østsiden.

I 1500 Favnes Dyb ere Gradienterne aabenbart betydelig sterkere end i 1000 Favnes Dyb. Imidlertid gaar, som vi have seet, Bevægelsen for en stor Del imod Gradienten. De effective Gradienter blive derfor kun Forskjellen mellem Gradienternes Størrelse paa modsatte Sider af Bækkenerne. Og disse Forskjeller blive ringe. Samtidig hermed vil Frictionens Virkning blive merkeligere, paa Grund af den større Nærhed til Havbunden. Herefter

Mayen Channel and from the maximum of pressure east of Jan Mayen can move cyclonically straight across the basin to the minimum of pressure. The effect of this we see in the curving upward of the isotherms and the lines of equal salinity throughout this tract.

In the Lofoten Deep, the pressure has its maximum in the eastern part, diminishing towards the west. The motion is here westerly and downward. Hence the greater the depth, the farther west it produces its maximum effect (deepest point of isotherms). — See Transverse Section XV, Pl. XI. At a depth of 1000 fathoms, the temperature-maximum lies at a considerable distance from the bank. In the space between, colder water is sucked in by the westward motion from the deep and from the sides.

Along the bank, in the direction of Spitzbergen, the motion sets northward, chiefly with diminishing pressure, and with the same effect as at a depth of 500 fathoms, viz., a tongue of relatively higher temperature, with colder water drawn up by suction along the bank.

The minimum of pressure in lat. 74° N brings up the coldest water of the Arctic Ocean to higher levels, whereas the minor pressure-maximum in lat. 77° N keeps the temperature comparatively high.

As regards the velocity of motion at a depth of 1000 fathoms, it is difficult to form any just conclusion, the vertical motions being so prominent there. A comparison between the isobar-systems at a depth of 1000 fathoms and of 500 fathoms, would seem however to indicate that the velocity at a depth of 1000 fathoms is somewhat less than at a depth of 500 fathoms.

At a depth of 1500 fathoms, the two basins of the North Ocean are separated one from the other (Pl. XLVII). In the southern, or the Norway Deep, we have an isobar, a current, and a temperature-system, much resembling that at 1000 fathoms. The temperature-maximum in lat. 71° N lies a little farther west, the downward motion proceeding in that direction. The reaction-currents beneath the pressure-maximum in the Lofoten Deep, are, it may be assumed, at a depth of 1500 fathoms, by comparison highly developed, since the bottom lies but very little deeper.

In the northern basin — the Swedish Deep — occurs at its south-west margin a strongly developed pressure-minimum, in its northern part a minor pressure-maximum. On the west side of the basin, the gradients are steeper than on the east. The motion must, therefore, on the west side, proceed towards the south, and upwards; on the east side towards the north, and downwards. The temperature (Pl. XXIV), in conformity herewith, is lowest on the west side and highest on the east.

At a depth of 1500 fathoms, the gradients are manifestly much steeper than at a depth of 1000 fathoms. Meanwhile, the motion proceeds to a great extent, as we have seen, against the gradient. Hence, the effective gradients are merely the difference between the magnitudes of the gradients on opposite sides of the basins. And these differences are but trifling. Moreover, the effect of friction will be more sensible from the greater proximity to the

er det at antage, at Strømhastighederne i 1500 Favnes Dyb kun blive smaa.

I de Dybder, der overstige 1500 Favne, vil Trykfordelingen være noget nær den samme som i dette Dyb. Trykmaximum i Norskedybet giver Temperaturmaximum ved Bunden (Pl. XXV) i Station No. 52 af —1°.17.

Det kolde Vand fra Jan Mayen Renden glider langs Bunden henimod Trykminimum i 68° Bredde. Trykmaximum under 71° Bredde giver Temperaturmaximum paa Bunden mellem Jan Mayen og Vesteraalen. En anticyclonisk Bevægelse fra dette Trykmaximums Nordside, fortsat, ved Reaction af den vestgaaende synkende varme Strøm fra den norske Side, mod Syd henimod Trykminimum i 68° Bredde, omcirkler, i Forbindelse med hin Strøm fra Jan Mayen Renden, Temperaturens Maximum. Dette bliver paa alle Sider omgivet af koldere Vand.

I Svenskedybet kommer, under Indflydelsen af Trykkets Minimum, Nordhavets koldeste Vand (—1°.7) frem langs Bunden fra det endnu uudforskede nordvestre Grønlandshav. Paa Spidsbergsiden er varmere Vand, med nordovergaaende, nedstigende Bevægelse mod Trykkets Maximum i 77° Bredde.

Som Karterne Pl. XXV og Pl. XXXV vise, svarer der til højere Temperatur paa Havbunden en højere Saltholdighed, til en lavere Temperatur en ringere Saltholdighed. Det første er det atlantiske Vands, det sidste det polare Vands Kjendemerke.

Vor Chemiker, Hr. Hercules Tornøe, har først[1] gjort opmerksom paa de to Maxima af Saltholdighed og dermed sammenfaldende Minima af Luft- eller Kvælstofholdighed, som findes paa Bunden i vort Nordhav. Hans Forklaring af Fænomenet er, som vi se, bleven fuldkommen bekræftet af mine Undersøgelser over Trykforholdene og Strømningerne.

12. Almindelig Oversigt over Nordhavets Strømninger.

Vandet i vort Nordhav hidrører fra to forskjellige Kilder, fra Atlanterhavet og fra det indre arctiske Polarhav. Drevet af de herskende Vinde paa Sydsiden og Østsiden af det islandsk-grønlandske Lufttryksminimum bevæger Nordatlanterhavets øvre Vandlag sig henimod de britiske Øer, Færøerne og Island. I Dybet møder det de Rygge, som forbinde disse Øer, og nødes til at bevæge sig i en Bue langs Ryggenes Vestside og Islands Syd- og Vestside. I de øvre Lag føres Vandet over Bankerne og Ryggene mellem Skotland og Færøerne directe, og over Islands Banker langs denne Øes Sydside, Vestside, Nordside og Østside ad Omvej ind i det norske Hav. Her breder det

[1] Den norske Nordhavs-Expedition. H. Tornøe. Chemi. S. 69—74.

sea-bed. Hence, it may be assumed that the current-velocities at a depth of 1500 fathoms are but trifling.

In depths exceeding 1500 fathoms, the distribution of pressure will be much the same as at that depth. The pressure-maximum in the Norway Deep gives a temperature-maximum at the bottom (Pl. XXV), Station 52, of —1°.17.

The cold water from the Jan-Mayen Channel moves along the bottom towards the pressure-minimum in lat. 68° N. The pressure-maximum in lat. 71° N occasions a temperature-maximum at the bottom between Jan Mayen and Vesteraalen. An anticyclonic motion from the north side of this pressure-maximum — passing on, by the reaction of the warm descending current flowing westward from the Norwegian side, towards the south, in the direction of the pressure-minimum lat. 68° N — encircles, in conjunction with the current from the Jan-Mayen Channel, the maximum of temperature. The latter is surrounded on all sides by colder water.

In the Swedish Deep, the coldest water of the North-Ocean (—1°.7) makes its way along the bottom, under the influence of the minimum of pressure, from the still unexplored tracts of the north-western region of the Greenland Sea. On the Spitzbergen side there is warmer water, with a descending motion setting northward, towards the maximum of pressure in lat. 77° N.

As shown by the maps Pl. XXV and Pl. XXXV, to a higher temperature on the sea-bed corresponds a greater proportion of salt, to a lower temperature a less amount of salt. The former is the characteristic of the Atlantic water, the latter that of the Polar water.

Mr. Hercules Tornøe, Chemist to our Expedition, was the first[1] to point out the two maxima of salinity, along with the minima of air- (or nitrogen) content occurring at the bottom of the North Ocean. His explanation of the phenomenon has been thoroughly borne out by my investigations on the pressure and the currents.

12. General Description of the Currents in the North Ocean.

The water in the North Ocean has its origin from two distinct sources, viz., the Atlantic and the inner part of the Arctic Polar Sea. Driven by the prevailing winds on the south and east sides of the Icelandic-Greenland minimum of atmospheric pressure, the upper strata of the North Atlantic move in the direction of the British Islands, the Færoes, and Iceland. In the deep, they meet the ridges that connect those islands, and are compelled to proceed in a curve along the west side of the ridges and the south and west sides of Iceland. Throughout the upper strata, the water is carried direct across the banks and the ridges between Scotland and the Færoes, and over the banks

[1] The Norwegian North-Atlantic Expedition. H. Tornøe. Chemistry, p. 69—74.

sig ud over Nordsøen, og indtager i sin Bevægelse langs Continentets Kyster de øvre Lag lige til Novaja Semlja og Spidsbergen. Ombøjet af Grønlandshavets Nordenvinde gaar det atlantiske Vand for en stor Del atter sydover langs Polarstrømmens Østgrændse, passerer østenfor Jan Mayen og svinger, østenfor Island, igjen ned i den centrale Del af det norske Hav.

Fra Færø-Shetland Renden af, hvor det atlantiske Vand afkjøles af det underliggende kolde Vand, som det selv ved sin Bevægelse er virksomt til at suge ind over Rendens Bund fra Norske-Dybet, synker det salte Vand med den saaledes erhvervede større Tæthed nedover og optræder ved Rendens Munding som iskoldt Vand af atlantisk specifisk Vægt i 500 Favnes Dyb. Længere mod Nord, mellem Island og Norge, danner det et Trykmaximum med Temperaturmaximum og Tæthedsmaximum samt Luftholdighedsminimum igjennem alle de dybere Lag.

Mellem Jan Mayen og Norge danner ogsaa det tungere atlantiske Vand i Dybet et Trykmaximum med Temperaturmaximum og Tæthedsmaximum samt Minimum af Luftholdighed, afkjølet som det bliver paa Syd-, Nord- og Vestsiden af koldere Vand.

Samtidig sender det indre Polarhav sine kolde og ved Issmeltning opspædede Vandmasser ned i Nordhavet langs Grønlands Østkyst. De øvre Lag finde igjen sit Udløb gjennem den nordlige Del af Danmarkstrædet, medens en mindre Del strømmer gjennem Jan Mayen-Renden østenfor Island ind i det norske Hav.

Imellem Grønland og Spidsbergen gaar i de dybere Lag Polarstrømmens Vand mod Dybet, ligesaa østenfor Jan Mayen og i Jan Mayen-Rendens vestlige Del. Gjennem disse Strømninger føres det fra det indre Polarhav kommende og i Overfladen om Vinteren afkjølede Vand ned i Dybene i Nordhavet. Det møder her det synkende atlantiske Vand. Polarvandet opvarmes og Atlanterhavsvandet afkjøles.

I 74° og i 68° Bredde stiger det kolde Vand fra Dybet op til højere Niveauer. Her have vi de nedstigende Strømmes Compensationsstrømme.

I det søndre Bækken ere de nedstigende Strømme varmere end i det nordre, og det samme bliver Tilfældet med de opstigende. Den laveste Temperatur ved Bunden er —1°.36. I det nordre Bækken er den laveste Temperatur paa Bunden i den hidtil udforskede Del af Havet —1°.7. Under den polare Vinter afkjøles Havvandet til —2°.1. Men denne Temperatur træffes ikke i Dybet. I dette er Temperaturen højere. Det nedsynkende atlantiske Vand har opvarmet Dybet. Denne Opvarmning finder især Sted i det sydlige Bækken, hvor Atlanterhavsvandet fornemmelig kommer til Synkning. I det nordlige Bækken er

of Iceland, along the south, the west, the north, and the east sides of that island, by circuitous routes into the Norwegian Sea. Here it is suffused over the North Sea, and, on its course along the coasts of the continent, occupies the higher strata, as far north as Novaja Semlja and Spitzbergen. Turned aside by the north winds of the Greenland Sea, the Atlantic water passes in great part again southward, along the eastern limit of the Polar current, flows to the east of Jan Mayen, and then rounds off again, east of Iceland, into the central portion of the Norwegian Sea.

From the Færoe-Shetland Channel, where the Atlantic water is cooled by the subjacent cold water, which by its own motion it is effective to draw in over the bottom of the channel from the Norway Deep, the salt water sinks by reason of the greater density thus acquired, and is met with at the mouth of the channel as ice-cold water of Atlantic specific gravity, 500 fathoms deep. Farther north, between Iceland and Norway, it constitutes a pressure-maximum, together with a temperature-maximum and a density-maximum, as also a minimum of air-content — throughout all the deeper strata.

Between Jan Mayen and Norway, the heavier Atlantic water likewise constitutes in the deep a pressure-maximum, along with a temperature-maximum and a density-maximum, as also a minimum of air-content, cooled as it is on the south, north, and west sides by colder water.

Simultaneously, the inner tracts of the Polar Sea send their cold masses of water, diluted by the melting of ice, down into the North Ocean, along the east coast of Greenland. The upper strata find their outlet through the northern part of Denmark Strait, whereas a smaller portion of the water passes through the Jan-Mayen Channel, east of Iceland, and thence into the Norwegian Sea.

Between Greenland and Spitzbergen, the water of the Polar current passes in the lower strata into the deep, as is also the case east of Jan Mayen and in the western part of the Jan-Mayen Channel. By these currents, the water coming from the inner tracts of the Polar Sea, and cooled during winter at the surface, is carried into the deeps of the North Ocean. Here it meets the sinking Atlantic water. The Polar water is warmed, the Atlantic water is cooled.

In lat. 74° N and lat. 68° N, the cold water from the deep rises to higher levels. Here, we have the compensation-currents of the descending currents.

In the southern basin, the descending currents are warmer than in the northern; and the same, too, is the case with the ascending. The lowest temperature at the bottom is —1°.36. In the northern basin, the lowest temperature at the bottom in the hitherto explored part of the Sea is —1°.7. During the Arctic winter, the water of the sea is cooled down to —2°.1. But this temperature is not met with in the deep. There, the temperature is higher. The sinking Atlantic water has warmed the lower strata. This heating takes place more especially throughout the southern basin, where the Atlantic water in par-

det hovedsagelig Polarvand, der stiger ned og op; kun ved Spidsbergen stiger atlantisk Vand ned.

Strømningerne i de forskjellige Retninger maa gjensidig compensere hverandre, naar Havets Vandmængde eller dets Niveau skal holde sig uforandret. De opstigende Strømmes Vandmasse maa være lige stor som de nedstigendes. At saa er Tilfældet, synes vel overensstemmende med de beskrevne verticale Bevægelser, navnlig naar vi tage Hensyn til den Opstigning, som finder Sted langs Bankernes dybere Skraaninger. I de højere Lag, hvor Bevægelsen foregaar ved horizontale Strømninger, kunne vi nærmere godtgjøre, at Compensation finder Sted. Fra 300 Favnes Dyb af er Nordhavet udestængt fra Atlanterhavet. I denne Dybde se vi (Pl. XLIV) Vandet komme ind mellem Grønland og Spidsbergen og strømme ud mellem Grønland og Island. Afstanden mellem Isobarerne betegner de enkelte Strømtraades Tversnit. Mellem de samme to Isobarer strømmer hele Vejen, naar Bevægelsen følger dem, den samme Vandmasse. Knibe Isobarerne sig sammen, øges Hastigheden i samme Forhold og omvendt, naar de fjerne sig fra hverandre. Se vi nu paa Kartet, finde vi, at Indstrømningen ved Spidsbergen sker gjennem 3 isobare Mellemrum, og i Danmarkstrædet sker Udstrømningen mellem de samme Isobarer. Der strømmer ligemeget Vand ud af Nordhavet i dette Niveau, som der strømmer ind.

Udføres den samme Undersøgelse for Overfladens Vedkommende efter Pl. XLIII, saa finder man følgende Antal af Mellemrum mellem to Isobarer ved Ind- og Udstrømningsaabningerne.

Indstrømning.		Udstrømning.	
Nordenfor Island	1 Mellemr.	Danmarkstrædet	6 Mellemr.
Færøerne til Skotland	6 —	Søndenfor Island	2 —
Grønlandshavet	8 —	Spidsbergen	2 —
		Novaja Semlja	5 —
Tilsammen	15 Mellemr.	Tilsammen	15 Mellemr.

Der strømmer altsaa i Overfladen ligesaa meget Vand ud af Nordhavet, som der strømmer ind i det. Dette er en interessant Verification af Strømkartet. Hvad Havets Overflade taber ved Fordunstning, faar det igjen ved Nedbør, Elvevand og Isbræer. Muligens condenseres en Del af det i Nordhavet fordunstede Vand først i det indre Polarhav, men dels kommer dette igjen ind i Nordhavet med Polarstrømmen, dels erstattes det ved Elvevand hidrørende fra Dampe, der ere optagne paa Atlanterhavet.

Den Tilforsel, som Nordhavets Dyb erholder af atlantisk Vand, godtgjøres ikke alene af dettes Temperatur, men ogsaa, som Tornøe har vist, af dets Saltholdighed og dets Luft- eller Kvælstofholdighed. Som ovenfor paapeget, er det især det søndre Bækken, det norske Hav, hvis Vand i Dybet for en stor Del er af atlantisk Oprindelse, om det end paa Grund af Berøring og Blanding med Polarvand

ticular is found to sink. Throughout the northern basin, it is chiefly Polar water that descends and rises; off Spitzbergen only, Atlantic water is found to descend.

The currents setting in different directions must compensate one another, provided the amount of water in the sea or its level shall keep unchanged. The discharge of water by the ascending currents must be equal to that by the descending. And that such is the case would seem to be in accordance with the vertical motions described, more particularly if we have regard to the ascent prevailing along the deeper declivities of the banks. In the higher strata, where the motion proceeds by horizontal currents, we are better able to prove that compensation actually occurs. From a depth of 300 fathoms, the North Ocean is shut out from the Atlantic. At this depth, we observe (Pl. XLIV) the water passing in between Greenland and Spitzbergen, and flowing out between Greenland and Iceland. The distance between the several isobars indicates the transverse sections of the different stream-threads. Between any two isobars flows, throughout the whole course, provided the motion proceed along them, the same quantity of water. Where the isobars converge, the velocity will increase, and the reverse take place where they diverge. Now, if we regard the map, we shall observe that the influx at Spitzbergen finds its way through 3 isobaric interspaces, and that the efflux passes through Denmark Strait between the same isobars. As much water flows out of the North Ocean at this level as flows into it.

Supposing the same investigation, as regards the surface, to be carried out according to Pl. XLIII, we shall find the following number of interspaces between two isobars at the inlet and outlet.

Influx.		*Efflux.*	
North of Iceland	1 Interspace.	Denmark Strait	6 Intersp.
Færoes to Scotland	6 Interspaces.	South of Iceland	2 —
Greenland Sea	8 —	Spitzbergen	2 —
		Novaja Semlja	5 —
Total . . .	15 Interspaces.	Total . .	15 Intersp.

Hence, an equal quantity of water flows at the surface out of the North Ocean as flows into it. This is an interesting verification of the Current-Map. Whatever loss the surface of the sea may sustain by evaporation, is made good by precipitation, river-water, and glaciers. Possibly, some part of the water evaporated in the North Ocean may not be condensed before it reaches the inner tracts of the Polar Sea; but if so, this water will again be partly brought into the North Ocean with the Polar current, or be compensated by river-water originating in vapour from the Atlantic.

The discharge of Atlantic water into the deep of the North Ocean, is not only proved by the temperature of the water, but also, as Tornøe has shown, by its salinity and content of air, or proportion of nitrogen. As pointed out above, it is more especially the southern basin, or Norwegian Sea, the water of which in great part is of Atlantic origin throughout the deep, though

har en Temperatur under 0°. Tornøe har vist, at Vandet i de dybeste Lag indeholder omtrent den samme Luftmængde som ved Overfladen, og at det er her, at Havvandet optager sin Luft. Med de nedstigende Strømme, som vi have paavist, føres Luften ned til Dybene; Havet er saaledes fuldstændig ventileret, og denne Betingelse for det organiske Livs Trivsel i alle Dybder og paa Havbunden er tilvejebragt ved Strømningernes Mekanisme.

Vi have seet, hvorledes Strømningernes Hastighed aftager mod Dybet, og at den i de store Dyb rimeligvis er temmelig ringe, men dog tilstrækkelig til at holde Vandets Circulation vedlige. De Aflagringer, der findes paa Havbunden, ere af en mere grovkornet Art ved Kysterne, hvor Strømmen er sterkest, og Landjorden, hvorfra Materialet tages, er nærmest, medens de finere Partikler findes i de store Dybder, hvor Vandet er roligere og Afstanden fra Land større. Her dækkes Bunden af Biloculinleret, hvis Hovedbestanddel er Skaller af Foraminiferer, især Globigeriner, og som i chemisk Henseende indeholder kulsur Kalk som Hovedbestanddel[1]. Om dette Ler siger J. Murray[2]:

"Den kulsure Kalk i det norske Hav bestaar hovedsagelig af Skaller af Globigeriner, der ere sunkne ned fra Overfladen, og nogle andre Arter Foraminiferer (mest Biloculiner), der leve ved Bunden. Paa nogle Steder nærmer denne Aflejring sig i sin Charakter til Atlanterhavets Globigerina-Ler eller Mudder, men er meget fattig paa pelagiske Skaller i Sammenligning med Aflejringerne under lavere Bredder. De pelagiske Foraminiferer og Pteropoder, der ere saa talrige i de tropiske Dele af Golfstrømmen, dø og falde tilbunds, idet de føres ind i Nordatlanterhavets koldere Strøg".

Efter disse Udtalelser af Mr. Murray er det at vente, at de varme nedstigende Strømninger i Nordhavet skulde medføre en større Rigdom paa kulsur Kalk paa Havbunden end de kolde opstigende. Et opmerksomt Studium af Schmelcks Afhandling og navnlig af hans Kart over Mængden af kulsur Kalk i Biloculinleret vil ogsaa i det hele taget stadfæste dette. Hele det søndre Bækken er rigt paa kulsur Kalk, medens det nordre Bækken er yderst fattigt, undtagen — og det er meget interessant — langs Spidsbergbanken og der, hvor vi under Greenwichs Meridian i 77° til 78° Bredde have et Trykmaximum, begge Steder med nedstigende Bevægelse af oprindelig atlantisk Vand. Den hos Schmelck antydede store Mængde af kulsur Kalk i Jan Mayen Renden svarer ogsaa til de sammesteds ovenfor omtalte nedadgaaende Strømninger. Imellem Island og Norge findes et Par Steder over 40 Procent kulsur Kalk, i Station No. 52 (Temperaturmaximum) over 45 Procent. Den yderst ringe Kalkmængde i Strøget Nordost for Jan

[1] Den norske Nordhavs-Expedition. Chemi. Af L. Schmelck.

[2] Encyclopædia Britannica. Norwegian Sea.

by contact and intermixture with Polar water it has a temperature of under 0°. Tornøe has shown that the water in the deepest strata contains about the same amount of air as at the surface, and that here it is sea-water absorbs its air. As we have pointed out, the air is carried, with the descending currents, down into the deep; thus the sea becomes thoroughly ventilated, and this condition for the existence of organic life at all depths and on the sea-bed, is brought about by the mechanism of the currents.

We have already seen how the velocity of the currents diminishes with depth, and that probably in the great deeps it is but trifling, though amply sufficient to keep up the circulation of the water. The deposits met with on the sea-bed are coarsely granulous in character off the coasts, where the current is strongest and the detritus-yielding land nearest, whereas the finer particles of matter occur in the great depths, where the water is calmer and the land more distant. Here the bottom is covered with Biloculina clay, the chief constituents of which are the shells of Foraminifera, more especially Globigerina, and which, regarded chemically, contain as their principal constituent carbonate of lime.[1] Respecting this subject, J. Murray states.[2]

"The carbonate of lime (in the Norwegian Sea) consists chiefly of the shells of Globigerina, which have fallen from the surface, and some other species of Foraminifera (the most frequent of which is Biloculina) which live on the bottom. In some places this deposit approaches in character the Globigerina ooze or mud of the Atlantic, but is very poor in pelagic shells when compared with the deposits in lower latitudes. The pelagic Foraminifera and Pteropod shells so abundant in tropical parts of the Gulf Stream are killed off and fall to the bottom as they are carried into the colder areas of the North Atlantic."

From these statements by Mr. Murray, there was reason to expect that the warm descending currents in the North Ocean would be attended with a greater amount of carbonate of lime on the sea-bed than the cold ascending ones. An attentive study of Schmelck's Memoir, and more especially of his map showing the amount of carbonate of lime in the Biloculina clay, will also in the main confirm this result. The whole of the southern basin is rich in carbonate of lime, whereas the northern basin is exceedingly poor, except — and this fact is very interesting — along the Spitzbergen Bank, and where, on the meridian of Greenwich, in lat. 77° to 78° N. we have a pressure-maximum, in both places with a descending motion of originally Atlantic water. The large amount of carbonate of lime found by Schmelck, in the Jan-Mayen Channel, corresponds to the above-mentioned descending currents in the same locality. Between Iceland and Norway, carbonate of lime, in a proportion of more than 40 per cent, is

[1] The Norwegian North-Atlantic Expedition. Chemistry. By L. Schmelck.

[2] Encyclopædia Britannica. Norwegian Sea.

Mayen turde ogsaa hidrøre, foruden fra den længere gjennemløbne Vej fra Atlanterhavet af, tildels fra, at Foraminiferskallerne her synke i en opstigende Strøm og saaledes i længere Tid ere udsatte for Søvandets tærende Virkning. Efter Alt synes der saaledes at være god Overensstemmelse mellem de organiske Afiejringer paa Bunden og vort Strømsystem.

Efter Zöppritz[1] fremgaar det nu existerende Strømsystem som Resultatet af Vindenes Arbejde i seculære Tidsrum. Som jeg har søgt at vise, udføres dette Arbejde derigjennem, at der dannes en Overflade, som afviger fra Niveaufladen, dels ved Vindenes directe Virkning og Jordens Rotation, dels ved de af Vindstrømningerne og Elvevandet vedligeholdte Uligheder i Søvandets Tæthed. Hvad de normale Vinde, Fordunstning og Nedbør udrette, efterat Strømsystemet er blevet constant, er at vedligeholde Strømfladen og med den Strømsystemet. De normale Vinde ere Resultatet af det normale Lufttryks Fordeling, hvilken igjen beror paa Temperaturens Fordeling. Men denne er afhængig i høj Grad af Havets Temperatur og af Fordelingen af Land og Vand. Vi komme saaledes til Solens Varme, Fordelingen af fast Land og Hav og Jordens Rotation som Hovedfactorer for Klima, Lufttryk, Temperatur, Fordunstning, Nedbør, Vinde og Havstrømme.

Forandringer i disse Grundbetingelser ville medføre Forandringer i Havets Strømninger, der kunne blive af stor Betydning for Klimatet. Seculære Forandringer af den relative Havstand ved Kysterne synes ikke at kunne forklares paa saadan Maade, da Strømfladens største Høide over Niveaufladen gjennem Havoverfladens dybeste Punkt kun gaar op til halvanden Meter.

En aarlig periodisk Variation i Havstrømmenes Bevægelse finder rimeligvis Sted i de øverste Lag. De dybere Lag ere ikke underkastede nogen saadan, ifølge Zöppritz' Undersøgelser[2]. Vindenes Styrke er i Nordhavet betydelig større om Vinteren end om Sommeren, og Lufttrykkets Minimum befinder sig altid ude over Havet[3]. Derimod er den fra Elvevandet og Sne- eller Issmeltning hidrørende Forhøjelse af Havniveauet under Kysterne betydelig større om Sommeren end om Vinteren. I hvilken Udstrækning disse Aarsager opveje hverandre, faa kommende Undersøgelser afgjøre.

Havstrømmenes Virkning paa de Landes Klima, som de berøre, er en anerkjendt Kjendsgjerning. Her kun en

[1] Wiedemanns Annalen, III. 4. S. 582.

[2] L. c. S. 601.

[3] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, April, m. Kart.

met with in a few places, nay at Station 52 (max. of temp.) it exceeds 45 per cent. The very trifling amount of lime met with in the tract north-east of Jan Mayen, may come, not only of the great distance traversed from the Atlantic, but in part also of the Foraminifera shells sinking here in an ascending current, and being thus exposed for a considerable time to the dissolving action of the sea-water. After all, there would accordingly appear to be fair agreement between the organic deposits on the sea-bed and our current-system.

According to Zöppritz,[1] the current-system as now existing is the work of the winds during a period of secular extent. As I have sought to show, this work is brought about by the formation of a surface deviating from the surface of level, partly by the direct action of the winds and the rotation of the earth, partly by the differences in the density of the sea-water, as maintained by the wind-currents and the river-water. As regards the effect of the normal winds, evaporation, and precipitation after the current-system has become constant, this consists in maintaining the current-surface, and along with it the current-system. The normal winds are the result of the normal distribution of atmospheric pressure, which in turn depends on the distribution of temperature. But this is dependent to a very great extent on the temperature of the sea and the distribution of land and water. Thus we come to the heat of the sun, the conformation of land and sea, and the rotation of the earth as principal factors in determining climate, atmospheric pressure, temperature, evaporation, precipitation, winds, and ocean-currents.

Any changes in these fundamental conditions will involve changes in the currents of the ocean, which may exert a great influence on climate. Secular changes in the relative sea-level at the coasts, cannot be explained, it would seem, in this way, since the greatest height of the current-surface above the surface of level through the deepest point of the sea-surface reaches only a metre and a half.

An annual periodic variation in the motion of ocean-currents takes place in all probability throughout the uppermost strata. The deeper strata are not subjected to such variation, according to Zöppritz' investigations.[2] The force of the winds in the North Ocean is considerably greater in winter than in summer, and the minimum of atmospheric pressure lies invariably out at sea.[3] On the other hand, the rise of the sea-level in immediate proximity to the coasts, occasioned by river-water and the melting of snow or ice, is much greater in summer than in winter. To what extent these causes counteract each other, it must rest with future investigations to determine.

The influence of ocean-currents on the climate of countries with which they come in contact, is a well-known

[1] Wiedemanns Annalen, III, 4, p. 582.

[2] Ibid. p. 601.

[3] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, April, with Chart.

Bemerkning. Det hænder ikke sjeldent, at, paa de norske meteorologiske Stationer, Luftens Middeltemperatur for Januar Maaned er højere end for December og for Februar. I Normalmedia for et Tidsrum af 20 Aar forsvinder vel denne Anomali, men samtlige Stationer fra Stad til Nordkap faa for Januar en Normaltemperatur, der kun er lidet lavere end Decembers, men merkelig højere end Februars[1]. Der indtræder aabenbart i Januar en Forsinkelse i Luftens Afkjøling paa den nævnte Kyststrækning. Det er denne, som mest directe bliver berørt af den atlantiske Strømning. Det er ligesom en Varmebølge i Januar passerede forbi i Havet. Gaa vi med en Strømhastighed af 10 Kvartmil i Døgnet langs Strømbanen sydover, komme vi i August, den varmeste Maaned, til den 50. Breddegrad i Atlanterhavet. Gaa vi mod Nord, komme vi i Sommermaanederne til Havet Nord for Novaja Semlja. Men her gjøre andre Forhold sig gjældende. Som bekjendt fandt Weyprecht her om Sommeren en Vandmasse af —2°, om Vinteren af —1°.5. Dette lader sig imidlertid forklare. Havet er forholdsvis grundt og paavirkes desto lettere af Atmosfæren. Om Vinteren herske sydlige og sydostlige Vinde, der føre det vistnok afkjølede, men relativt varmere Vand fra Østhavet derop. Om Sommeren derimod herske nordlige Vinde, og disse føre det indre Sibiriske Ishavs til —2° afkjølede Vand sydover.

fact. One remark only on this subject. It occurs not infrequently that, at the Norwegian Meteorological Stations, the mean temperature of the air for the month of January is higher than the mean for December and for February. In normal means for a period of 20 years this anomaly is found to disappear; but all the Stations from Stad to the North Cape exhibit for January a normal temperature but little lower than the normal temperature for December, though remarkably higher than that for February.[1] Manifestly, in the month of January a retardation must take place in the cooling of the air along the said extent of coast. It is this part that is acted on most directly by the Atlantic current. A wave of heat would seem, as it were, to pass by in the sea during the month of January. Proceeding southward, with a current-velocity of 10 nautical miles in 24 hours, along the path of the current, we arrive in August, the warmest month of the year, at the 50th parallel of latitude in the Atlantic Ocean. Proceeding northward, we reach in the summer months the sea north of Novaja Semlja. But here other conditions assert their influence. Weyprecht, we know, found there in summer a mass of water of —2°, in winter one of —1.°5. This however will admit of explanation. The sea is comparatively shallow, and hence the more exposed to atmospheric influence. In winter, the prevailing winds are southerly and south-easterly, and carry up to that region the cooled, but relatively warmer water from the Barents Sea. In summer, on the other hand, northerly winds prevail; and these carry southward the water from the inner tracts of the Siberian Arctic Ocean, cooled to —2°.

13. Nordhavets Overflade.

Ved Constructionen af Strømfladen have vi antaget Lufttrykket constant over hele Havet. I Virkeligheden er dette ikke Tilfældet. Lufttrykket overtager en Del af det Tryk, som vi have tillagt Strømfladen. Den virkelige Overflade er Strømfladen, nedtrykket af Lufttrykket. Denne Nedtrykning beregnes saaledes. I Strømfladens dybeste Punkt er Lufttrykket 755.7 mm og Fladens verticale Ordinat —0.01 m. Kaldes Lufttrykket i et andet Punkt b, saa er i dette Punkt Overskuddet af Lufttryk $b - 755.7$ mm. Da Kviksølvet er 13.5959 Gange tungere end Ferskvand og $\frac{13.5959}{S_o}$ Gange tungere end Søvand af Tætheden S_o, svarer til en Kviksølvsøjle, der er $b - 755.7$ mm høj, en Vandsøjle af $\frac{13.5959}{S_o}(b - 755.7)$ Millimeter. Vi have før (Pl. XXXI) regnet med Lufttrykket, reduceret til Normaltyngden. Her er Spørgsmaalet om den observerede Kviksølvhøjde og den virkelige Vandhøjde. Vi maa saaledes sætte Havoverfladens Nedtrykning i et Punkt, hvor Vandets Tæthed er S_o og Lufttrykket b, lig

[1] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, S. 150 og 151.

13. The Surface of the North Ocean.

When constructing the current-surface, we assumed the atmospheric pressure constant over the whole tract of ocean. This, however, is not really the case. The atmospheric pressure exerts part of the pressure we have ascribed to the current-surface. The true surface is the current-surface depressed by atmospheric pressure. This depression is computed as follows. At the deepest point of the current-surface, the atmospheric pressure is 755.7 mm. and the vertical ordinate of the surface —0.01 m. Calling the atmospheric pressure at another point b, then the surplus of atmospheric pressure at this point will be $b - 755.7$ mm. Since mercury is 13.5959 times heavier than fresh water and $\frac{13.5959}{S_o}$ times heavier than sea-water of the density S_o, a column of mercury having the height of $b - 755.7$ mm. will correspond to a column of water of $\frac{13.5959}{S_o}(b - 755.7)$ millimetres. We have previously computed (Pl. XXXI) with the atmospheric pressure reduced to normal gravity. Here we have to do with the observed

[1] Zeitschrift der österreichischen Gesellschaft für Meteorologie, 1884, p. 150, 151.

$$\triangle h = \frac{13.5959}{1000\, S_o} \cdot \frac{b - 755.7}{1 - \beta \cos 2\,\varphi} \text{ Meter.}$$

Uden merkelig Fejl kunne vi her sætte $S_o = 1.027$ og $\varphi = 70^0$ og faa da

$$\triangle h = 0.0132\,(b - 755.7) \text{ Meter}$$

eller Havoverfladens Højde over Niveaufladen gjennem dens dybeste Punkt

$$h = S + 0.01 - 0.0132\,(b - 755.7) \text{ Meter}$$

hvor S er Strømfladens verticale Coordinat.

Man faar saaledes for Lufttrykket:

756 mm	$h = S + 0.006$ m
757	$S - 0.007$
758	$S - 0.020$
759 mm	$h = S - 0.034$ m
760	$S - 0.047$
761	$S - 0.060$.

Beregningen af Overfladens verticale Coordinater er udført paa grafisk Vej, idet Tabellens Værdier for Tillægget til S er anbragt ved Curverne for S langs Meridianerne (de samme, som benyttedes til Construction af Strømfladen), og den nye Curves Ordinater ere overførte paa et Kart. Mellem de saaledes fundne Punkter for Ordinaterne 0.1, 0.2 til 1.4 m droges, med Vejledning af Pl. XLIII, Ligehøjdelinierne for Havoverfladen i Kartet Pl. XLVIII. Forskjellen mellem dette Kart og Pl. XLIII er ikke stor.

Nordhavet har sit dybeste Punkt i 68°.5 N. Br. og 1° W. Lgd. Dets Overflade stiger, først langsomt, senere raskere, mod Kysterne og naar ved Færøerne op til en Højde af 0.4 m, ved Island, Jan Mayen og Spidsbergen op til en Højde af 0.6 m, ved Finmarken til 0.9 m, ved Skotland til 1.0 à 1.1 m, ved Novaja Semlja til 1.1 m, ved Grønland og ved det sydlige Norge og Jylland til 1.4 m.

Efter Kartet har Nordsøens Bredder og den vestlige Del af Østersøen omtrent det samme Niveau[1]. Dette er overensstemmende med Resultatet af de nyere Præcisionsnivellements. At Østersøen ved Memel kan staa 0.5 m højere end ved Svinemünde, synes uden Vanskelighed at kunne forklares dels ved de herskende Vestenvinde, der løfte Niveauet op mod disse Kyster, dels ved Virkningen af de store Elve Oder og Weichsel, hvis Vand føres østover mod Memel.

[1] Jeg vil her udtrykkelig bemerke, at Beregningen af Strømningerne m. m. i Nordsøen kun er udført forsøgsvis, for at kunne gjøre Fremstillingen i Karterne noget fuldstændigere. En strengere gjennemført Undersøgelse efter samtlige tilstedeværende Iagttagelser, navnlig af Temperatur og Saltholdighed, vil kunne give Resultater, der i flere Retninger kunne corrigere mine Overslagsberegninger. Det af det tyske Admiralitet udgivne Verk "Die Ergebnisse der Untersuchungsfahrten S. M. Knbt. "Drache" (Capt. Holzhauer) in der Nordsee in den Sommern 1881, 1882 u. 1883" kom mig først ihænde, efterat ovenstaaende var nedskrevet. I det hele taget synes Observationerne fra "Drache" at stemme vel med vor Strømtheori.

height of the mercury and the true height of the water. Hence, we must put the depression of the sea-surface at a point where the density of the water is S_o and the pressure b equal to

$$\triangle h = \frac{13.5959}{1000\, S_o} \cdot \frac{b - 755.7}{1 - \beta \cos 2\,\varphi} \text{ metre.}$$

Without appreciable error, we can here take $S_o = 1.027$ and $\varphi = 70^0$; accordingly

$$\triangle h = 0.0132\,(b - 755.7) \text{ metre,}$$

or the height of the sea-surface above the surface of level through its deepest point,

$$h = S + 0.01 - 0.0132\,(b - 755.7) \text{ metre,}$$

in which S is the vertical co-ordinate of the current-surface.

Thus we get for the atmospheric pressure

The computation of the vertical co-ordinates of the surface was made diagrammatically, the values in the Table for the addition to S having been applied at the curves for S along the meridians (the same selected for the construction of the current-surface), and the ordinates of the new curve have been transferred to a map. Between the points thus found for the ordinates 0.1, 0.2 to 1.4 m., were drawn, by the aid of Pl. XLIII, the lines of equal height for the sea-surface in the map Pl. XLVIII. The difference between this map and Pl. XLIII is not great.

The North Ocean has its deepest point in lat. 68°.5 N and long. 1° W. Its surface rises, at first slowly, afterwards more rapidly, as it approaches the coasts, and reaches at the Færoes a height of 0.4 m., at Iceland, Jan Mayen, and Spitzbergen a height of 0.6 m., at Finmark of 0.9 m., at Scotland of 1.0 to 1.1 m., at Novaja Semlja of 1.1 m., at Greenland, Southern Norway, and the coast of Jutland of 1.4 m.

According to the map, the shores of the North Sea and the western part of the Baltic lie nearly at the same level.[1] This result is in accordance with the latest levellings of precision. That the surface of the Baltic at Memel may be 0.5 m. higher than its surface at Swinemünde, admits, it would appear, without difficulty of being explained, in part by the prevailing westerly winds, that raise the level against these coasts, in part by the effect

[1] I must here expressly remark, that the computation of the currents, etc., in the North Sea has been merely undertaken as an attempt to give a more complete representation in the maps. A more rigorous examination, based on all available observations, in particular those referring to temperature and salinity, will be attended with results that in several respects may correct my estimated computations. The work published by the German Admiralty "Die Ergebnisse der Untersuchungsfahrten S. M. Knbt. "Drache" (Capt. Holzhauer) in der Nordsee in den Sommern 1881, 1882 u. 1883," did not reach me till the above had been written. Generally, the observations from the "Drache" seem to agree well with our theory of ocean-circulation.

I Meteorologien reducere vi Barometerhøjderne til Havfladen. Vi skulde reducere dem til en bestemt Niveauflade. Som Pl. XLVIII viser, ligger Havets Niveau ved Christiania omtrent 1.5 Meter højt, medens det ved Vardø kun ligger 0.9 Meter højt. Forskjellen er 0.6 Meter, hvortil svarer en Forskjel i Barometerhøjden af 0.05 mm. Da denne Størrelse er Grændsen for den Nøjagtighed, hvormed vore Stationsbarometres constante Correction er bestemt, har Havets Niveauforskjel ingen praktisk Betydning for Lufttrykkets Reduction til Niveauflade.

Ude i Midten af Havet ligger Overfladen 1.5 m lavere end Niveauet ved Christiania. Her bliver Reductionen til det sidste over 0.1 mm. Dette er imidlertid en Størrelse, som ikke overstiger den Usikkerhed, man i Almindelighed kan paaregne ved Barometerobservationer paa Havet[1]. For vort Lufttrykkart, Pl. XXXI, er den, med dettes Usikkerhed, af ringe Betydning.

14. Slutningsbemerkninger.

I den foreliggende Afhandling har jeg søgt at begrunde Vandets Bevægelse i vort Nordhav som en Følge saavel af de normale Vinde som af Ulighederne i Vandets Tæthed. Den første Aarsag er den overvejende, men den sidste har ogsaa sin fulde Betydning. Jeg betragter dette Arbejde som et Forsøg, dog ikke som en blot og bar Hypothese, men som en ved consekvente Beregninger gjennemført Iderække, der, udgaaende fra kjendte Kræfter og deres Virkemaade, har ledet til Resultater, som i mange Henseender og i mange Punkter stemme overens med de af Observationerne givne virkelige Forhold. De Coefficienter, jeg har benyttet, f. Ex. Forholdet mellem Vindhastighed og Strømhastighed, Grændsefladens Dybde, trænge til yderligere Verification, og de numeriske Data have for vigtige Punkters Vedkommende været magre, navnlig gjælder dette Søvandets specifiske Vægt, Lufttrykkets Fordeling over Havet og tildels Dybderne. Jeg maa bede erindret, at da vi i 1876 rejste ud paa vor Expedition, havde jeg ikke nogen bestemt Tanke om, at det skulde blive muligt at række saa langt med mine Studier som til den oceaniske Circulation. Alt var da ubekjendt, og Dybder, Temperatur og Vandets chemiske Egenskaber indtoge den første Plads i vore Tanker. At det har været mig muligt at føre Arbejdet saa vidt, som skeet er, skyldes for en væsentlig Del mine Medarbejdere, Commandørcaptein Wille, der havde organiseret Lodningerne, og hans Officierer, der assisterede ham i deres Udførelse, Captein Petersen og Captein Grieg, Professor Waage, der organiserede de chemiske Arbejder, og Chemikerne Svend-

[1] Den norske Nordhavs-Expedition. Meteorologi. Af H. Mohn. Side 40.

resulting from the great rivers, the Oder and the Vistula, the water of which is carried east, towards Memel.

In meteorology, it is the custom to reduce the heights of the barometer to the sea-level. We should rather reduce them to a given surface of level. As shown by Pl. XLVIII, the level of the sea at Christiania lies about 1.5 metre high, whereas at Vardø it lies only 0.9 metre high. The difference is 0.6 metre, to which corresponds a difference in the height of the barometer of 0.05 mm. As this quantity represents the limit of accuracy with which the constant correction of our Station-Barometers is determined, the difference in the sea-level has no practical importance for the reduction of atmospheric pressure to a surface of level.

In the middle of the Sea, the surface lies 1.5 m. lower than the level at Christiania. There, the reduction to the latter will be more than 0.1 mm. Meanwhile this is a quantity that does not exceed the uncertainty we as a rule may expect with barometric observations at sea.[1] As regards our Map of Atmospheric Pressure, Pl. XXXI, with its inherent uncertainty, it is of trifling importance.

14. Concluding Remarks.

In the present Memoir, I have sought to explain the motion of the water in the North Ocean as produced alike by the normal winds and the differences in the density of the water. The former cause predominates, but the latter too has full significance. I regard this research as an attempt, not indeed as a mere hypothesis but as a series of ideas carried out by consistent computations, which, proceeding from known forces and their mode of action, have led to results that in many respects and on many heads agree with the actual results given by the observations. The coefficients made use of, e. g., the relation between the wind-velocity and the current-velocity, the depth of the limiting-surface, need additional verification, and in many important points the numerical data have proved but meagre: this applies in particular to the specific gravity of the sea-water, the distribution of atmospheric pressure over the sea, and partly to the depths. The reader must bear in mind that, when, in 1876, we started on our Expedition, I had no definite idea of being able to advance so far with my studies as oceanic circulation. All was then an unknown field of research, and depth, temperature, and the chemical properties of water laid claim to the first place in our labours. The possibility of my having carried on the investigations to so advanced a stage, must be ascribed in great measure to my colaborators: Commodore Wille, who organised the soundings, and his officers, who assisted him in taking them, Capt. Petersen and Capt. Grieg; Professor Waage, who organised the chemical work,

[1] The Norwegian North-Atlantic Expedition. Meteorology. By H. Mohn. P. 40.

sen, Tornoe og Schmelck, som udførte dem. Endvidere skylder jeg min Tak til Hrr. A. S. Steen og N. Oftedal, som have assisteret mig med Beregningerne, der have været meget vidtløftigere, end det af min Afhandling kan sees, idet de simplificerede Methoder først efterhaanden bleve fundne.

De større Dybsø-Expeditioner, som flere af Europas og Amerikas større Stater i de senere Aar have udsendt, ville give et Materiale til Beregningen af Strømningerne i de store Verdenshave, som i mange Stykker er bedre end det, jeg har havt for Studiet af vort Nordhav. Jeg skulde meget ønske, at Nogen vilde forsøge et saadant Arbejde, og at min Afhandling kunde være til Vejledning derved. Andre Pligter ville ikke tillade mig, som Meteorolog, at paatage mig et saa vidtløftigt Arbejde.

De Ideer, min Methode har givet mig om Vandets Bevægelse i Oceanerne, vil jeg afholde mig fra at fremsætte her, da jeg har den Tro, at ikke Raisonnements eller Overslag, men kun gjennemførte Beregninger kan føre til et blivende Resultat.

and the chemists to the Expedition, Mr. Svendsen, Mr. Tornøe, and Mr. Schmelck, by whom it was performed. Furthermore, I am indebted to Mr. A. S. Steen and Mr. N. Oftedal, who have given me their assistance in working out the computations, many of which were exceedingly complicated, far more so than will appear from my Memoir, the simplified methods having been found only from time to time, as the work proceeded.

The great deep-sea Expeditions despatched of late years by several of the chief nations of Europe and America, will yield material for investigating the currents in the great oceans of the world, better in many respects than what I have had at my disposal for the study of the North Ocean. I very much wish that some one would undertake a work of the kind, and that my Memoir might serve to guide his researches. Other duties, viz., those devolving on a meteorologist, will not admit of my attempting a work so extensive.

The ideas my method has suggested concerning the motion of the water in the different oceans, I shall refrain from communicating here, believing as I do that neither argument nor estimate, but carefully worked out computations alone, can lead to a lasting result.

IV.

Piezometret som Dybdemaaler.

Vandets Sammentrykkelighed.

Paa Nordhavs-Expeditionens 2. Togt i 1877 anvendtes et Piezometer, og paa det sidste Togt i 1878 3 Piezometre, der ved Lodningerne vare fastgjorte paa Lodlinen sammen med Dybvandsthermometrene, et Par Favne over Lodderne (og Vandhenter). Kun et af disse Piezometre har ved nærmere Eftersyn vist sig paalideligt. Ved grafisk at opstille Piezometeraflæsningerne som Function af Lodskuddene give de to Instrumenter uregelmæssige Curver, medens det tredie giver, paa Smaaafvigelser nær, en continuerlig, ganske svagt krummet Linie.

Piezometrenes Construction. De vare construerede efter Angivelse af J. Y. Buchanan, Challenger-Expeditionens Chemiker, af Casella i London. Reservoiret stod opad, og Capillarrøret med sin nedre, aabne, Ende i en kugleformet Kop med Kviksølv, der med en kort Kautschukslange holdtes fast til Capillarrøret. En tynd Glasstang, rørformet, anbragt mellem Røret og Slangen, skaffede det ydre Tryk Adgang til Kviksølvet i Koppen[1]. Instrumentets Constanter vare mig opgivne af Hr. Buchanan, der havde bestemt dem ved Vejninger af Piezometret, dels tomt, dels fyldt med destilleret Vand til forskjellige Merker. Paa Capillarrøret er en Millimeterskala indridset. Det indre er fyldt med luftfrit destilleret Vand. En magnetisk Glas-Index med Haar til Fjedring markerer Kviksølvets Stand i Capillarrøret, ligesom paa Miller-Casellas Dybvandsthermometre. Ved de to Piezometre, hvis Angivelser ikke have vist sig brugelige, har rimeligvis Indexen siddet for løst.

Piezometrets Stand ved forskjellige Temperaturer. Før Rejsen, i 1878, blev Piezometret, No. 32109,

[1] Se Side 10.

IV.

The Piezometer as a Depth-Meter.

Compressibility of Water.

On the second cruise of the North-Atlantic Expedition, in 1877, a piezometer was employed, and on the last cruise, in 1878, three piezometers were in use, which, when having to take a sounding, we made fast to the line, along with the deep-sea thermometers, a few fathoms above the weights (and the water-bottle). Only one of these piezometers proved on closer inspection trustworthy. By laying down on a diagram the readings of the piezometers as function of the depths, two of the instruments were found to give irregular curves, whereas the third gave, with but trifling deviations, a continuous, faintly-curved line.

Construction of the Piezometers. — These instruments were made by Casella of London, in accordance with directions from J. Y. Buchanan, Chemist to the "Challenger" Expedition. The bulb is uppermost, and the capillary tube has its lower open end dipped into a globular-shaped cup filled with mercury, which a short piece of india-rubber tubing keeps attached to the capillary tube. A slender glass rod (tubular), inserted between this tube and the rubber-tubing, affords the outer pressure admission to the mercury in the cup.[1] The constants of the instrument I had from Mr. Buchanan, who determined them by weighing the piezometer, when empty and when filled up to different scale-divisions with distilled water. On the capillary tube, a millimetre-scale has been etched in. The internal volume contains distilled air-free water. A magnetic glass index, with a hair acting as a spring, marks the reading of the mercury in the capillary tube, as with the Miller-Casella deep-sea thermometers. The two piezometers whose indications did not prove reliable, had in all probability the index too loose.

Reading of Piezometer at different Temperatures. — Previous to the cruise in 1878, piezometer No. 32109 was

[1] See page 10.

omhyggeligt sammenlignet med det meteorologiske Instituts Normalthermometer ved forskjellige Temperaturer, og dets Stand ved 0^0 C undersøgt i smeltende Is. Efter disse Observationer beregnedes en Formel for Piezometrets Stand som Function af Temperaturen paa følgende Maade:

Er C det indre Volum af Piezometret ved 0^0 C og regnet til Delstregen 0 mm paa Capillarrøret,

c det Volum, som indesluttes mellem to Delstreger, eller som svarer til 1 mm Høide af Capillarrøret,

m_o Piezometrets (Kviksølvtoppens) Stand ved 0^0 C,
m_t Piezometrets Stand ved t^0 C,
α og β Constanter (Glashyllets kubiske Udvidelse),
v_o Vandets Volum ved 0^0 C,
v_t Vandets Volum ved t^0 C,
Alt ved almindeligt Lufttryk,
saa har man:
$C - c\,m_o =$ det indre Volum ved 0^0,
$(C - c\,m_t)(1 + \alpha t + \beta t^2)$ det indre Volum ved t^0.

carefully compared with the Standard-Thermometer of the Meteorological Institute at various temperatures, and its reading at 0^0 C. determined in melting ice. From these observations, a formula was computed for the reading of the piezometer as function of the temperature, in the following manner: —

Taking C as the internal volume of the piezometer at 0^0 C. and reckoned to the division 0 mm. on the capillary tube;

c as the volume contained between two marks of division, or that corresponding to a height of 1 mm. of the capillary tube;

m_o reading of piezometer (top of mercury) at 0^0 C.;
m_t reading of piezometer at t^0 C.;
α and β constants (cubic expansion of the glass envelope);
v_o volume of the water at 0^0 C.;
v_t volume of the water at t^0 C.;
at ordinary atmospheric pressure;
then we have,
$C - c\,m_o =$ the internal volume at 0^0;
$(C - c\,m_t)(1 + \alpha t + \beta t^2)$ the internal volume at t^0,

$$\frac{v_t}{v_o} = \frac{(C - c\,m_t)(1 + \alpha t + \beta t^2)}{C - c\,m_o}.$$

$$\text{eller: } (or)\ m_o + \left(\frac{C}{c} - m_t\right)\frac{v_o}{v_t}\,.\,t\,.\,\alpha + \left(\frac{C}{c} - m_t\right)\frac{v_o}{v_t}\,.\,t^2\beta = \frac{C}{c} - \left(\frac{C}{c} - m_t\right)\frac{v_o}{v_t}.$$

Af de ved Sammenligningerne med Normalthermometret fundne Værdier for t og m_t beregnes, efter de mindste Kvadraters Methode, de sandsynligste Værdier for m_o, α og β.

Man har efter Sammenligningerne med Normalthermometret

From the values given by the comparisons with the the Standard-Thermometer for t and m_t, I computed, by the method of least squares, the most probable values for m_o, α, and β.

From the comparisons with the Standard-Thermometer, we have

$t =$	$0^0.00$	$5^0.72$	$8^0.35$	$11^0.52$	$15^0.31$
	mm	mm	mm	mm	mm
$m_t =$	11.40	13.50	13.00	10.96	7.03

og efter Buchanan $C = 4.2422$ Cub.centimeter
$c = 0.000456$ — (Kaliber jevn).

and, according to Buchanan, $C = 4.2422$ cubic centimetres
$c = 0.000456$ — (bore uniform).

Værdierne af $v_t : v_o$ ere tagne af Broch's Tabel[1]

The values of $v_t : v_o$ have been taken from Broch's Table.[1]

Observationerne give følgende Ligninger: [Logarithmer]

The observations give the following equations [logarithms]: —

$$\begin{aligned}
m_o & & & = [1.0569049] \\
m_o &+ [4.7254323]\,\alpha &+ [5.4828283]\,\beta &= [1.1014178] \\
m_o &+ [4.8896949]\,\alpha &+ [5.8113814]\,\beta &= [1.1214507] \\
m_o &+ [5.0294400]\,\alpha &+ [6.0908925]\,\beta &= [1.1359070] \\
m_o &+ [5.1529337]\,\alpha &+ [6.3379089]\,\beta &= [1.1551766]
\end{aligned}$$

Endeligningerne blive:

The normal equations are:

$$\begin{aligned}
[0.6989700]\,m_o + [\ 5.5797110]\,\alpha + [\ 6.6396590]\,\beta &= [1.8144221] \\
[5.5797110]\,m_o + [10.6076384]\,\alpha + [11.7058232]\,\beta &= [6.7154528] \\
[6.6396590]\,m_o + [11.7058232]\,\alpha + [12.8307266]\,\beta &= [7.7809459]
\end{aligned}$$

[1] Volume et Poids spécifique de l'eau pure. Travaux et mémoires du Bureau international des poids et mesures.

hvoraf (*whence*) $m_o = 11.398018$ $\log m_o = 1.0568298$

$\alpha = 0.000025813$ $\log \alpha = 5.4118416-10$

$\beta = -0.0000003603$ $\log \beta = 3.5566085_n-10.$

Indsættes disse Værdier, faaes

Substituting these values, we get

for $t =$	$0^0.0$	$5.^072$	$8^0.35$	$11.^052$	$15^0.31$
Observeret Stand (*Observed Reading*)	11 .40	13 .50	13 .00	10 .96	7 .03
Beregnet Stand (*Computed Reading*)	11 .398	13 .53	12 .94	11 .00	7 .02
$\triangle = O - B$	+0 .002	—0 .03	+0 .06	—0 .04	+0 .01

Sandsynlig Fejl af en Ligning: $\delta = \pm 0.037$ mm.
Værdien af m_t for tilsvarende Værdier af t kan beregnes paa følgende Maade:

Probable error of an equation: $\delta = \pm 0.037$ mm.
The value of m_t for corresponding values of t, may be computed in the following manner: —

$$m_t = \frac{C}{c} - \left(\frac{C}{c} - m_o\right)\frac{v_t}{v_o}\cdot\frac{1}{1+\alpha t+\beta t^2}$$

Efter (*According to*) Broch er $\dfrac{v_t}{v_o} = \begin{cases} 1 - 0.000060306\,t + 0.0000079279\,t^2 - 0.000\,000042604\,t^3 \\ 1 - a\,t + b\,t^2 - c\,t^3 \end{cases}$

altsaa (*hence*) $m_t = \dfrac{C}{c} - \left(\dfrac{C}{c} - m_o\right)(1 - a\,t + b\,t^2 - c\,t^3)\,(1 - \alpha\,t - (\beta - \alpha^2)\,t^2 - \ldots)$

$$m_t = \frac{C}{c} - \left(\frac{C}{c} - m_o\right)(1 - (a+\alpha)\,t + (b - \beta + \alpha^2)\,t^2 - c\,t^3)$$

$$m_t = 9303.070 - 9291.672\,(1 - 0.000086119.\,t + 0.0000082889.\,t^2 - 0.000\,000042604.\,t^3)$$

mm

$$m_t = 9303.070 - [3.9680939]\,(1 - [5.9350990]\,t + [4.9184969]\,t^2 - [2.6294504]\,t^3).$$

Efter denne Formel beregnes følgende Tabel:

According to this formula, I have computed the following Table: —

$t =$	$0^0.0$	$0^0.1$	$0.^02$	$0^0.3$	$0^0.4$	$0^0.5$	$0^0.6$	$0^0.7$	$0^0.8$	$0^0.9$
-1^0	10 .52	10 .42	10 .33	10 .23	10 .13	10 .02	9 .92	9 .81	9 .71	9 .60
-0^0	11 .40	11 .32	11 .23	11 .15	11 .07	10 .98	10 .89	10 .80	10 .71	10 .61
$+0^0$	11 .40	11 .48	11 .55	11 .63	11 ,71	11 .78	11 .85	11 .92	11 .99	12 .06
$+1^0$	12 .12	12 .18	12 .25	12 .31	12 .37	12 .43	12 .48	12 .54	12 .59	12 .64
$+2^0$	12 .69	12 .74	12 .79	12 .83	12 .88	12 .92	12 .96	13 .00	13 .04	13 .08

Paa Expeditionen i 1878 blev Piezometret No. 32109 sendt sammen med 3 Dybvandsthermometre 10 Gange til Havbunden. Af Lodskuddene, Havvandets specifiske Vægt, dets Sammentrykkelighed og Tyngdens Størrelse kan det ved Havbunden stedfindende Tryk i Atmosfærer beregnes.

Trykket som Function af Dybden.

Er h Dybden i engelske Favne, à 1.82876694 Meter,

b Tyngdens Tilvæxt med Dybet pr. engelsk Favn = 0.000 00041698,

φ Bredden,

β en Constant = 0.00259,

S Havvandets specifiske Vægt ved Atmosfærens Tryk, i Dybden h, (Vand af 4° C = 1),

Σ Havvandets middel-specifiske Vægt i den trykkende Vandsøjle,

a_o en Constant $= \dfrac{1.82876694}{13.5959 \times 0.76} = 0.1769851$;

$\log a_o = 9.2479368-10$,

On the cruise in 1878, the piezometer No. 32109 was sent to the bottom 10 times, along with 3 deep-sea thermometers. From the sounded depth, the specific gravity of the sea-water, its compressibility, and the force of gravity, the pressure at the bottom, in atmospheres, may be computed.

The Pressure as Function of the Depth.

Let h be the depth in English fathoms, (1 fathom = 1.82876694 metre);

b the increase of gravity with depth per Eng. fath. = 0.00000041698;

φ the latitude;

β a constant = 0.00259;

S the specific gravity of the sea-water (atmospheric pressure), at the depth h (water of 4° C. = 1);

Σ the mean specific gravity of the sea-water in the pressing column of water;

a_o a constant $= \dfrac{1.82876694}{13.5959 \times 0.76} = 0.1769851$;

$\log a_o = 9.2479368-10$;

Er η' og ε' Constanter, der udtrykke Havvandets Sammentrykkelighed,
p Trykket i Atmosfærer i Dybden h.
saa har man (Se Side 148),

Let η' and ε' be constants expressing the compressibility of sea-water;
p the pressure, in atmospheres, at the depth h;
then we have (See page 148)

$$dp = \frac{a_o S(1-\beta \cos 2\varphi)(1+bh)\,dh}{1-\eta' p + \varepsilon' p^2}.$$

$\eta' - \varepsilon' p$ er altsaa Havvandets Sammentrykkeligheds-coefficient. Ved Integration findes, da $p = 0$, naar $h = 0$, og S varierer saa lidet med Dybden, at man kan regne med constant Σ,

$\eta' - \varepsilon' p$ is accordingly the coefficient of compression for sea-water. Integrating, we find, as $p = 0$ when $h = 0$, and S varies so little with depth as to admit of computing with constant Σ,

$$p = \frac{a_o \Sigma (1-\beta \cos 2\varphi)\left(1+\frac{b}{2}h\right)}{1-\frac{\eta'}{2}\left(1-\frac{2}{3}\frac{\varepsilon'}{\eta'}p\right)p}\,.\,h.$$

Det rene Vands Sammentrykkelighedscoefficient kan — ifølge Travaux et mémoires du bureau international des poids et mesures, Tome II, D, 30 fremstilles ved Formelen

The coefficient of compression for pure water, may, according to *Travaux et mémoires du bureau international des poids et mesures*, Tome II, D, 30, be expressed by the formula

$$\eta_T = 50.153 - 0.158995.\,T - 0.0003141113.\,T^2 \text{ Milliontedele } (\textit{millionths}),$$

hvor T er Temperaturen ($\eta_o = 50.153$).

in which T is the temperature ($\eta_o = 50.153$).

Regnault har fundet Sammentrykkelighedscoefficienten for Havvand af en Temperatur af 17°.5 og en specifisk Vægt af 1.0264 at være 43.6 Milliontedele (Moussons Fysik. I. S. 253). Antages den samme Lov at være gjældende for Havvand som for rent Vand med Hensyn til Temperaturens Indflydelse paa Sammentrykkeligheden, saa bliver ved 0° Havvandets Coefficient

Regnault found the coefficient of compression for sea-water with a temperature 17°.5 and a specific gravity 1.0264 to be 43.6 millionths (Moussons Physik, I, p. 253). Now, assuming the same law to apply for sea-water as for pure water with regard to the influence of temperature on compressibility, the coefficient for sea-water at 0° will be

$$\eta'_o = 43.6 + 2.7825 + 0.0962 = 46.4787 \text{ Milliontedele } (\textit{millionths}).$$

J. Y. Buchanan har fundet, at Havvandets Coefficient er 92.3 Procent af det rene Vands[1]. Regnet med ovenstaaende Værdier findes saaledes for 0°: $\eta'_o = 50.153 \times 0.923 = 46.291 \times 10^{-6}$. Middel af disse to Bestemmelser er 46.385, og jeg sætter saaledes for Havvand ved $T°$ og en Atmosfæres Tryk

$$\eta' = 46.385 - 0.1590.\,T - 0.000314.\,T^2$$

Efter foreløbig Beregning fandtes den til ε' svarende Værdi for rent Vand $\varepsilon = 0.006107$ Milliontedele. Jeg sætter derfor $\frac{\varepsilon'}{\eta'} = \frac{\varepsilon}{\eta_o} = 0.0001218$ og $\frac{2}{3}\frac{\varepsilon'}{\eta'} = 0.00008118$. Den nøjagtige Værdi af $\frac{2}{3}\frac{\varepsilon}{\eta_o}$ bliver, som nedenfor vil sees, 0.00008384. Det gjør ingen Forskjel i Værdierne for p, om man regner med den ene eller den anden af disse Værdier for $\frac{\varepsilon'}{\eta'}$.

Til Beregningen af η' anvender jeg Middeltallet af Havtemperaturerne i Stykker paa 100 Favnes Dybde fra Overfladen til Bunden. Disse ere givne af Temperaturrækkerne eller Temperaturtversnittene gjennem vedkommende Station. Middeltallet kaldes T og Nævneren i Formelen for p bliver

J. Y. Buchmann found the coefficient of sea-water to be 92.3 per cent compared to that of pure water.[1] Computing with the above-given values, we find accordingly for 0°: $\eta'_o = 50.153 \times 0.923 = 46.291 \times 10^{-6}$. The mean of these two determinations is 46.385, and therefore I take for sea-water at $T°$ and a pressure of one atmosphere

$$\eta' = 46.385 - 0.1590.\,T - 0.000314.\,T^2$$

A preliminary computation gave as the value for pure water corresponding to ε', $\varepsilon = 0.006107$ millionths. Hence I take $\frac{\varepsilon'}{\eta'} = \frac{\varepsilon}{\eta_o} = 0.0001218$, and $\frac{2}{3}\frac{\varepsilon'}{\eta'} = 0.00008118$. The true value of $\frac{2}{3}\frac{\varepsilon}{\eta_o}$ will, as shown farther on, be 0.00008384. It makes no difference in the values for p whether we compute with the one or the other of these values for $\frac{\varepsilon'}{\eta'}$.

For computing η' I make use of the mean of the temperatures of the sea for intervals of 100 fathoms, from the surface te the bottom. These temperatures are given by the serial temperatures, or by the temperature-sections passing through the Station. The mean I call T, and the numerator in the formula for p becomes

[1] Professor Tait har fundet (Proceedings of the Royal Society Edinburgh f. 1883, S. 224) 92.5 Procent, og senere (L. c. f. 1884. Side 758) 92.4 Procent.

[1] Professor Tait has found (Proceedings of the Royal Society Edinburgh 1883, p. 224) 92.5 per cent, and later (ibid. for 1884. p. 758) 92.4 per cent.

$$1 - \tfrac{1}{2}(46.385 - 0.1590.\,T - 0.000314.\,T^2)(1 - 0.00008118\,p)\,p$$

p beregnes forresten ved successiv Tilnærmelse (Se S. 148).

Den følgende Tabel indeholder Observationerne og de deraf beregnede Tryk ved Havbunden i Atmosfærer.

p I compute by successive approximation (See page 148).

The following Table contains the observations and the pressures at the bottom computed from them, in atmospheres.

No.	Stations No.	h	φ	Σ	T	η'	p
1	358	93	78° 2′	1.02694	2.°8	45.937	16.95
2	359	416	78 2	760	2 .0	46.066	75.97
3	307	1216	74 58	786	0 .26	46.344	222.89
4	297	1280	72 36	786	—1 .07	46.555	234.66
5	353	1333	77 58	781	—0 .66	46.490	244.48
6	354	1343	78 1	781	—0 .66	46.490	246.33
7	349	1487	76 30	782	—1 .20	46.575	272.90
8	305	1590	75 1	787	—0 .78	46.500	291.93
9	350	1686	76 25	774	—1 .36	46.602	309.66
10	302	1985	75 16	1.02765	—1 .40	46.607	365.01

Bestemmelse af Vandets Sammentrykning i Piezometret.

Er t Temperaturen ved Havbunden,

m Piezometrets Stand (ved Temperaturen t) ved almindeligt Lufttryk,

m' Piezometrets Stand (ved Temperaturen t) ved Havbunden, angivet af Indexens Stilling,

η_t og ε og $\varkappa$ Constanter ($\varkappa$ = Glassets Sammentryknings-coefficient),

saa har man:

Vandets Volum ved t^0 og almindeligt Lufttryk = $(C - c\,m)\,(1 + \alpha t + \beta t^2) = V$

Vandets Volum ved t^0 og Trykket p paa Havbunden = $(C - c\,m')\,(1 + \alpha t + \beta t^2)\,(1 - \varkappa p) = V'$

Determination of the Compression of the Water in the Piezometer.

With t as the temperature at the sea-bottom;

m as the reading of the piezometer (temperature t) at ordinary atmospheric pressure;

m' as the reading of the piezometer (temperature t) at the bottom, indicated by the position of the index;

η_t, ε and $\varkappa$ as constants, $\varkappa$ = the coefficient of compression of the glass;

we have: —

The volume of the water at t^0 and ordinary atmospheric pressure = $(C - c\,m)\,(1 + \alpha t + \beta t^2) = V$;

The volume of the water at t^0 and the pressure p at the bottom = $(C - c\,m')\,(1 + \alpha t + \beta t^2)\,(1 - \varkappa p) = V'$;

$$V - V' = V(\eta_t\,p - \varepsilon\,p^2),\ \text{hvor}\ \eta_t = 50.153 - 0.1590.\,t - 0.000314\,t^2$$

$$\frac{V - V'}{V} = \frac{(C - c\,m) - (C - c\,m')\,(1 - \varkappa\,p)}{C - c\,m} = \eta_t\,p - \varepsilon\,p^2$$

$$(C - c\,m)\,\eta_t\,p - (C - c\,m)\,\varepsilon\,p^2 - (C - c\,m')\,\varkappa\,p = (C - c\,m) - (C - c\,m') = c\,(m' - m)$$

$$\left(\frac{C}{c} - m\right)\eta_t\,p - \left(\frac{C}{c} - m\right)\varepsilon\,p^2 - \left(\frac{C}{c} - m'\right)\varkappa\,p = m' - m$$

Hver af de 10 Observationer giver en Ligning af denne Form, og af disse kunde Constanterne η, ε og $\varkappa$ bestemmes.

Da Værdien af η_t maa antages at være bestemt nøjagtigere ved Fysikernes Observationer, (ved hvilke Glassets Sammentrykning og Temperaturens Indflydelse bedre kan bestemmes) end den kan findes af Piezometerobservationerne, har jeg antaget η_t bekjendt og søgt af Ligningerne at bestemme de sandsynligste Værdier for ε og $\varkappa$.

Ligningernes Form bliver da

Each of the 10 observations gives an equation of the above form; and from these equations the constants η, ε, and $\varkappa$ admit of being determined.

Since the value of η_t in all probability has been determined more accurately by the observations of the physicists (from which the compression of the glass and the effect of the temperature can be determined better) than it will admit of being found by the piezometer-observations, I have assumed η_t as known, and have sought to determine from the equations the most probable values of ε and $\varkappa$.

The form of the equations will accordingly be

$$\left(\frac{C}{c} - m\right)p^2.\,\varepsilon + \left(\frac{C}{c} - m'\right)p\,\varkappa = \left(\frac{C}{c} - m\right)\eta_t\,p - (m' - m).$$

Efter Observationerne med Dybvandsthermometer og Piezometer, og efter Formlerne for m_t og η_t haves:

From the observations with the deep-sea thermometer and the piezometer, and from the formulæ for m_t and η_t, we have: —

No.	t	m	m'	$m'-m$	η_t mill.	$\left(\frac{C}{c}-m\right)\eta_t\,p.$	$\left(\frac{C}{c}-m\right)\eta_t\,p-(m'-m)$
		mm.	mm.	mm.		mm.	mm.
1	$2^0.6$	12.958	20.5	7.542	49.7375	7.832	0.290
2	0 .77	11.969	46.7	34.731	50.0304	35.313	0.582
3	—1 .35	10.177	110.1	99.923	50.3676	104.324	4.401
4	—1 .37	10.157	115.0	104.843	50.3702	109.840	4.997
5	—1 .42	10.105	119.4	109.295	50.3782	114.458	5.163
6	—1 .29	10.237	120.0	109.763	50.3576	115.274	5.511
7	—1 .53	9.992	131.2	121.208	50.3956	127.806	6.598
8	—1 .47	10.053	140.0	129.947	50.3861	136.691	6.744
9	—1 .53	9.992	147.0	137.008	50.3956	145.020	8.012
10	—1 .50	10.022	170.7	160.678	50.3908	170.927	10.249.

Betingelsesligningerne blive [Logarithmer]: (ε og $\varkappa$ Gange 1 Million)

The conditional equations will be [logarithms] (ε and $\varkappa$ times 1 million): —

			Obs.	Ber. (*Comp.*)	$O-B$	
[0.42636] ε	+ [9.19684] $\varkappa$	= [9.46240]	0.290	0.142	+0.148	mm.
[1.72933]	[9.84707]	[9.76492]	0.582	0.894	—0.312	
[2.66431]	[0.31154]	[0.64355]	4.401	4.511	—0.110	
[2.70903]	[0.33366]	[0.69871]	4.997	4.908	+0.089	
[2.74466]	[0.35127]	[0.71290]	5.163	5.252	—0.089	
[2.75119]	[0.35451]	[0.74123]	5.511	5.318	+0.193	
[2.84016]	[0.39846]	[0.81938]	6.598	6.309	+0.289	
[2.89870]	[0.42731]	[0.82892]	6.744	7.069	—0.325	
[2.94992]	[0.45259]	[0.90372]	8.012	7.815	+0.197	
[3.09276]	[0.52288]	[1.01068]	10.249	10.375	—0.126	
				MF =	±0.188	

Endeligningerne blive

The normal equations will be

$$4537499.00\ \varepsilon + 15114.27000\ \varkappa = 40331.6600$$

$$15114.27\ \varepsilon + 52.09441\ \varkappa = 135.7365$$

hvoraf findes (*from which is found*) $\varepsilon = 0.00623600 \times 10^{-6}$; $\log \varepsilon = 1.7949062-10$

$\varkappa = 0.7963205 \times 10^{-6}$; $\log \varkappa = 3.9010879-10.$

Sandsynlig Fejl af en Observation $\delta = \pm 0.155$ mm.
— — „ ε $\pm 0.00678 \times 10^{-6}$
— — „ $\varkappa$ $\pm 0.1175 \times 10^{-6}$

Probable error of an observation $\delta = \pm 0.155$ mm.
— — „ ε $\pm 0.00678 \times 10^{-6}$.
— — „ $\varkappa$ $\pm 0.1175 \times 10^{-6}$.

Af Piezometerobservationerne beregnes Trykket efter Formelen

From the piezometer-observations, the pressure is computed by the formula

$$p = \frac{m'-m}{\left(\frac{C}{c}-m\right)(\eta_t - \varepsilon p) - \left(\frac{C}{c}-m'\right)\varkappa}$$

med følgende Resultat:

with the following result: —

No.	p beregnet (*comp.*)	p efter Lodskud (*by sounding*)	$O - B$
1	16.62 at.	16.95 at.	+0.33 at.
2	76.66	75.97	−0.69
3	223.15	222.89	−0.26
4	234.45	234.66	+0.21
5	244.69	244.48	−0.21
6	245.88	246.33	+0.45
7	272.22	272.90	+0.68
8	292.69	291.93	−0.76
9	309.19	309.66	+0.47
10	365.27	365.01	−0.26

MF = ± 0.432

Og af de saaledes beregnede Tryk beregnes Dybden efter Formelen:

And from the pressures thus computed the depth is calculated according to the formula: —

$$h = \frac{1 - \frac{\eta'}{2}\left(1 - \frac{2}{3}\frac{\varepsilon}{\eta}p\right)p}{a_0\,\Sigma\left(1 - \beta\cos 2\varphi\right)\left(1 + \frac{b}{2}h\right)} \cdot p,$$

med følgende Resultat:

with the following result: —

No.	h ber. (*comp.*)	h obs.	$O - B$
1	91.2 Fv. (*Fms.*)	93 Fv. (*Fms.*)	+1.8 Fv. (*Fms.*)
2	419.8	416	−3.8
3	1217.1	1216	−1.1
4	1278.9	1280	+1.1
5	1334.1	1333	−1.1
6	1340.6	1343	+2.4
7	1483.3	1487	+3.7
8	1594.1	1590	−4.1
9	1683.5	1686	+2.5
10	1986.5	1985	−1.5

MF = ± 2.31 Favne (*Fms.*); $\delta = \pm$ 1.94 Favne (*Fms.*).

Det er hidtil forudsat, at Lodskuddene angive den rigtige Dybde uden at være beheftede med nogen constant eller systematisk Fejl. Den i Forhold til dens egen Værdi store sandsynlige Fejl, hvormed ε udkommer af Ligningerne, opfordrer imidlertid til at undersøge, om muligens den hele fundne Værdi af ε skulde være et Resultat af systematiske Fejl ved Lodskuddene og saaledes savne Realitet. Prøven kan gjøres ved at sætte $\varepsilon = 0$, beregne den under denne Forudsætning udkommende sandsynligste Værdi for $\varkappa$, og dermed de tilsvarende Værdier af h til Sammenligning med de observerede Lodskud.

Man faar da $\varkappa'$ = Summen af Coefficienterne for $\varkappa$ i Betingelsesligningerne divideret med Summen af Leddene paa højre Side af Lighedstegnet eller

It has hitherto been assumed that the soundings give the true depth, not being affected by any constant or systematic error. Meanwhile, the relatively large probable error of ε, as compared with its actual value deduced from the equations, calls for investigating whether, perhaps, the whole value of ε that I have found may not be a result of systematic errors attaching to the soundings, and thus want reality. The proof can be made by putting $\varepsilon = 0$, working out the most probable value of $\varkappa$ under that supposition, and with this also the corresponding values of h, to compare with the observed soundings.

We then get $\varkappa'$ = the sum of the coefficients for $\varkappa$ in the conditional equations, divided by the sum of the terms to the right of the sign of equality, or

$$\varkappa' = \frac{52.546}{20.9195} = 2.5118 \times 10^{-6} \qquad \log \varkappa' = 4.3999884 - 10,$$

og dermed

and with this value of $\varkappa$

No.	Ber. h' (*Comp.*)	Obs. h	Forskjel (*Diff.*)	
1	94.3 Fv. (*Fms.*)	93 Fv. (*Fms.*)	—1.3 Fv. (*Fms.*)	
2	430.7	416	—14.7	
3	1225.2	1216	—9.2	
4	1285.1	1280	—5.1	
5	1338.5	1333	—5.5	
6	1345.2	1343	—2.2	
7	1483.3	1487	+3.7	
8	1589.7	1590	+0.3	
9	1675.2	1686	+10.8	
10	1962.1	1985	+22.9	M. F. = ± 3.8 Favne (*Fms.*)

Differentserne vise, at den antagne Formel med Leddet $p^2 \varepsilon$ er berettiget; Leddets Udeladelse fører til Værdier for Dybderne, der udvise en bestemt systematisk Fejl ved de beregnede Dybder, det er ved Formelen uden εp^2, og desuden Fejl af en Størrelse, som er utænkelig, over 10 Favne. Som ovenfor vist, giver Formelen med εp^2 regelmæssigt Tegnskifte og moderate Størrelser i Differentserne mellem Observation og Beregning.

Opstilles grafisk højre Side af Betingelsesligningerne som Function af Dybderne eller Trykkene, faar man Punkter i en Curve, hvis aabenbar paraboliske Character fordrer et Led af Formen $p^2 \varepsilon$.

Vi kunne saaledes anse den fundne Værdi for ε for at have reel Værdi, og som den af Observationerne fremgaaende sandsynligste.

En lignende Undersøgelse med Hensyn til Glassets Sammentrykkelighedscoefficient har jeg anstillet paa følgende Maade. De systematiske Fejl, som nærmest skulde hænge ved Lodskuddene, skulde være en Følge af, at Lodlinen stod paa skraa. En gjennemsnitlig constant Skraahed giver Fejl, der voxe med Dybden, og de fundne Lodskud maa altid være for store, større end den sande verticale Dybde. En mindre Dybde svarer til en mindre Værdi af $\varkappa$. Sættes $\varkappa'' = 0.592641$, log $\varkappa'' = 3.77279$, og beregnes, med den sandsynligste Værdi af ε, Dybderne, saa faar man følgende Værdier h'' for disse.

Antager man, at Lodlinen har havt en constant Skraahed af 5° 14′.5, og multiplicerer man Lodskuddene med cos 5° 14′.5, saa faar man følgende Værdier h''' for Dybderne:

The differences show that the adopted formula, with the term $p^2 \varepsilon$, is warranted; the omission of the term leads to values for the depths that exhibit a definite systematic error in the computed depths, i. e., from the formula omitting εp^2, and besides errors of a magnitude quite out of the question, viz., exceeding 10 fathoms. As shown above, the formula with εp^2 gives a regular change of signs and moderate magnitudes of the differences between observation and computation.

Suppose the right side of the conditional equations to be set down diagrammatically, as function of the depths or of the pressures, we shall get points in a curve, whose obviously parabolic character requires a term of the form $p^2 \varepsilon$.

Hence the value found for ε may be considered to possess reality, and as the most probable that can be deduced from the observations.

A similar investigation with regard to the coefficient of compression of the glass, I have made as follows. The chief systematic errors that encumber the soundings are caused apparently by the obliquity of the line. An average constant obliquity gives rise to errors increasing with depth, and the depths sounded must invariably be too great, exceeding the true vertical distance to the bottom. A less depth corresponds to a less value of $\varkappa$. Putting $\varkappa''=0.592641$, log $\varkappa'' = 3.77279$, and calculating with the most probable value of ε, we get the following values, h'', for the depths.

Assuming the line to have a constant obliquity of 5° 14′.5, and multiplying the soundings by cos 5° 14′.5, we get the following values, h''', for the depths: —

No.	h''	h'''	$h'''-h''$	
1	90.8 Fv. (*Fms.*)	92.6 Fv. (*Fms.*)	+1.8 Fv. (*Fms.*)	
2	418.1	414.3	—3.8	
3	1212.4	1211.1	—1.3	
4	1273.6	1274.6	+1.0	
5	1328.6	1327.4	—1.2	
6	1335.0	1337.4	+2.4	
7	1477.2	1480.8	+3.6	
8	1587.1	1583.3	—3.8	
9	1676.5	1679.0	+2.5	
10	1978.0	1976.7	—1.3	M. F. = ± 2.27 Fv. (*Fms.*)

Differentserne $h'''-h''$ ere saagodtsom identiske med Forskjellerne mellem Lodskuddene og de af de sandsynligste Værdier for ε og $\varkappa$ beregnede Dybder. En constant Skraahed af Lodlinen fører saaledes til en constant Correction (praktisk talt) af Glassets Sammentrykkelighedscoefficient, som den gjør mindre end naar Linen var lodret.

Den fundne sandsynligste Værdi for $\varkappa$, 0.796 Milliontedele, er i sig selv allerede paafaldende liden, sammenlignet med de ellers ved Sammentrykningsundersøgelser fundne og benyttede Værdier (1.5 til 3). En yderligere Formindskelse af Værdien for $\varkappa$ har derfor ikke Sandsynligheden for sig, og man føres til den Slutning, at Lodskuddene ere tagne uden merkelig systematiske Fejl hidrørende fra Skraahed af Linen, og saaledes angive Dybderne med en Nøjagtighed, der væsentlig er begrændset alene ved tilfældige Observationsfejl.

Disse Observationsfejls Størrelse kunne vi gjøre os Rede for paa følgende Maade.

Den sandsynlige Fejl af en enkelt Aflæsning af Piezometrets Stand eller Indexens Stilling, sætter jeg til ± 0.075 mm $= d\,m'$. Den sandsynlige Fejl af en Bestemmelse af Piezometerstanden m ved en bestemt Temperatur under almindeligt Tryk er væsentlig afhængig kun af den Nøjagtighed, med hvilken Temperaturen er bestemt. Ved de her benyttede Observationer er Temperaturen ved Havbunden bestemt hver Gang med 3 forskjellige Thermometre, saaledes at den sandsynlige Fejl af Middeltallet af deres Angivelser kan nøjagtigt beregnes. Jeg kalder den $d\,t$. Af Tabellen for Piezometrets Stand som Function af Temperaturen finder man Værdien af $\left(\frac{d\,m}{d\,t}\right)$. Saaledes faar man følgende Tabel.

The differences $h'''-h''$ are well-nigh identical with the differences between the sounded depths and the depths computed from the most probable values of ε and $\varkappa$. Thus, a constant obliquity of the line implies a constant correction (practically speaking) of the coefficient of compression for the glass, which it renders less than if the line were vertical.

The most probable value found for $\varkappa$, 0.796 millionths, is in itself remarkably small compared to the values (1.5 to 3) which have been found and adopted in investigations of compression. Hence a further diminution of the value for $\varkappa$ has not probability in its favour; and we are led to the conclusion that the soundings have been taken without appreciable systematic errors arising from obliquity of the line — and will therefore indicate the depths with a precision chiefly limited by accidental errors of observation.

The magnitude of these errors of observation may be ascertained in the following manner.

The probable error of a single reading of the piezometer, or the position of the index, I put at ± 0.075 mm. $= d\,m'$. The probable error of a determination of the piezometer-reading m, at a given temperature under ordinary pressure, is chiefly dependent on the precision with which the temperature has been determined. For the observations made use of here, the temperature at the bottom was determined on each occasion with 3 different thermometers, and thus the probable error of the mean of their several indications admits of being computed. I call it $d\,t$. From the Table for the reading of the piezometer as function of the temperature, we find the value of $\left(\frac{d\,m}{d\,t}\right)$. Hence we get the following Table: —

No.	t	$\left(\frac{d\,m}{d\,t}\right)$	$d\,t$	$d\,m$
1	2°.6	0.4 mm.	± 0°.070	± 0.0280 mm.
2	0 .77	0.7	8	56
3	—1 .35	1.0	7	70
4	—1 .37	1.0	18	180
5	—1 .42	1.0	16	160
6	—1 .29	1.0	19	190
7	—1 .53	1.1	30	330
8	—1 .47	1.1	58	638
9	—1 .53	1.1	62	572
10	—1 .50	1.0	± 0 .050	± 0.0500
Middel (*Mean*)		0.94	± 0°.033	± 0.0298

$$d\,(m'-m) = \sqrt{(d\,m')^2 + (d\,m)^2} = \sqrt{0.075^2 + 0.030^2} = \pm 0.081 \text{ mm.}$$

Anm. Denne Værdi er mindre end den ovenfor fundne, ± 0.155, da i denne sidste Usikkerheden i Lodskuddene (Trykkene) ogsaa indgaar. Den til $d\,(m'-m)$ svarende Usikkerhed i Trykkene er i Gjennemsnit

$$d\,p = 2.239\,d\,(m'-m)$$

Remark. — This value is less than the value found above, ± 0.155, since in the latter the errors attaching to the soundings (the pressures) are also included. The error in the pressures corresponding to $d\,(m'-m)$ averages

$$d\,p = 2.239\,d\,(m'-m),$$

og den til dp svarende Usikkerhed i Dybderne er i Gjennemsnit $dh = 5.483 \,.\, dp$

and the error in the depths corresponding to dp averages $dh = 5.483 \,.\, dp$;

$$\text{altsaa (\textit{hence})} \; dh = 5.483 \times 2.239 \times d\,(m'-m) = 12.275\; d\,(m'-m).$$

$d\,(m'-m) = 0.155$ giver $dh = 1.91$ Favn, nær overensstemmende med det tidligere Resultat, $dh = 1.94$ Favn.

Kaldes den sandsynlige Fejl af en Bestemmelse af Dybden, beregnet efter Piezometeraflæsning, dh_p, saa er

$d\,(m'-m) = 0.155$ gives $dh = 1.91$ fathoms, nearly agreeing with the former result $dh = 1.94$ fathoms.

Now calling the probable error of a determination of depth, computed from a piezometer-reading, dh_p, then

$$dh_p = 12.275 \times 0.081 = \pm\, 0.995 \text{ Favn } (\textit{fm.}).$$

Kaldes den sandsynlige Fejl af en Bestemmelse af Dybden ved et Lodskud dh_l og den sandsynlige Fejl, der fremkommer ved Sammenligningen mellem de tagne Lodskud og de, af de observerede Værdier af $m'-m$, med de af disse flydende Værdier for Trykket, beregnede Værdier for Dybderne, $\triangle h$, saa har man, da $\triangle h$ indeslutter saavel Fejlene i Lodskud som i Piezometeraflæsninger,

And calling the probable error of a determination of depth by a sounding dh_l, and the probable error calculated from a comparison between the soundings taken and the values for the depths, as computed from the observed values of $m'-m$ and the values for pressure resulting thence, $\triangle h$, we have, $\triangle h$ including alike the errors in the soundings and in the piezometer-readings,

$$\triangle h^2 = dh_l^2 + dh_p^2$$

$$dh_l = \sqrt{\triangle h^2 - dh_p^2} = \sqrt{1.94^2 - 0.993^2} = \pm\, 1.66 \text{ Favne } (\textit{Fms.}).$$

Dybdebestemmelsen med Piezometret skulde saaledes være ikke saalidet nøjagtigere end ved Lodskuddene.

Dette gjælder vedkommende her benyttede Piezometer.

Determinations of depth with the piezometer should, therefore, be considerably more reliable than by sounding.

This applies to the piezometer used on the present occasion.

Overfører man de med og for dette fundne Constanter paa et andet Piezometer, maa man tage Hensyn til den Virkning, den sandsynlige Fejl af ε og $\varkappa$ vil have paa Bestemmelsen af Dybderne, og man faar da betydelige Fejl.

If we transfer the constants found with and for this instrument to another piezometer, regard must be paid to the influence which the probable error of ε and $\varkappa$ will have on the computed depths, and the result will be considerable errors.

Differentieres Ligningen for p (Side 202) m. H. t. ε og $\varkappa$, saa faar man

Differentiating the equation for p (page 202) with respect to ε and $\varkappa$, we get

$$dp = \frac{p}{\left|\dfrac{m'-m}{\left(\frac{C}{c} - m\right)p^2}\right| - \varepsilon}\, d\varepsilon + \frac{\left|\dfrac{\frac{C}{c} - m'}{\frac{C}{c} - m}\right|}{\left|\dfrac{m'-m}{\left(\frac{C}{c} - m\right)p^2}\right| - \varepsilon}\, d\varkappa + \frac{1}{\left(\frac{C}{c} - m\right)(\eta_t - \varepsilon p) - \left(\frac{C}{c} - m'\right)\varkappa} \,.\, d\,(m'-m).$$

Beregner man dh efter denne Formel og Formelen for $\dfrac{dh}{dp}$, med

Computing dh according to this formula and the formula for $\dfrac{dh}{dp}$, with

$$d\,(m'-m) = 0.081 \text{ mm}, \quad d\varepsilon = 0.00678 \text{ mill.} \quad d\varkappa = 0.1175 \text{ mill.},$$

saa faar man

we get

	$\frac{dh}{d\,(m'-m)}$	$\frac{dh}{d\varkappa}$	$\frac{dh}{d\varepsilon}$	
No. 1	1.0	+ 0.2	+ 0.2	$dh = \pm$ 1.0 Favne (*Fms.*)
2	1.0	1.2	4.5	4.8
3	1.0	3.0	39.5	39.8
4	1.0	3.2	43.8	44.1
5	1.0	3.3	47.8	48.1
6	1.0	3.4	48.4	48.7
7	1.0	3.7	59.6	59.8
8	1.0	4.0	69.3	69.4
9	1.0	4.3	77.7	77.8
10	1.0	5.1	110.2	110.2

For med Fordel at kunne anvende Piezometret som Dybdemaaler maa man altsaa beregne Dybderne strengt med de af de bedste Lodskud udledede Constanter. I dette Tilfælde kan Piezometret give en udmerket Control for Lodskuddene, et Maal for disses Nøjagtighed og en paalidelig Erstatning for mislykkede Lodskud, naar man er sikker paa, at Instrumentet har været ved Bunden.

Hence, in order to use advantageously the piezometer as a depth-meter, the depths must be rigorously computed with the constants found from the best soundings. In that case, the piezometer will afford an excellent means of control for sounded depths, a measure of their precision, and a trustworthy compensation for unsuccessful soundings, provided it be quite certain that the instrument has been at the bottom.

Man kan udvikle h i en Række efter Potentserne af $(m'-m)$, eller man kan opstille en herpaa grundet empirisk Formel

We can develop h in a series progressing according to the powers of $(m'-m)$, or take an empirical formula founded upon it, e. g.,

$$h = \frac{a}{\Sigma(1-\beta\cos 2\varphi)}(m'-m) + \frac{b}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^2 + \frac{c}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^3 + \dots$$

og bestemme a, b og c ved de mindste Kvadraters Methode. Man faar da følgende Betingelsesligninger [Logarithmer].

and determine a, b, and c by the method of least squares. We shall then have the following conditional equations [logarithms]: —

$$\begin{array}{llll}
[0.86491]\, a + & [1.74239]\, b + & [2.61987]\, c = & [1.96848] \\
[1.52787] & [3.06858] & [4.60930] & [2.61909] \\
[1.98677] & [3.98643] & [5.98610] & [3.08493] \\
[2.00769] & [4.02823] & [6.04877] & [3.10721] \\
[2.02566] & [4.06426] & [6.10286] & [3.12483] \\
[2.02752] & [5.06797] & [6.10843] & [3.12808] \\
[2.07061] & [4.15415] & [6.23768] & [3.17231] \\
[2.10086] & [4.21462] & [6.32839] & [3.20104] \\
[2.12384] & [4.26057] & [6.39729] & [3.22686] \\
[2.19312] & [4.39908] & [6.60504] & [3.29776]
\end{array}$$

Endeligningerne blive:

The normal equations will be

$$\begin{array}{rrrr}
115344.\ a + & 14621307.\ b + & 1912735673.\ c = & 1456854 \\
14621307.\ a + & 1912740543.\ b + & 257081182958.\ c = & 184843697 \\
1912735673.\ a + & 257081182958.\ b + & 35422403423676.\ c = & 24200418357
\end{array}$$

hvoraf *(whence)* $a = 12.25275$ $\quad\log a = 1.0882340$

$b = 0.003132885$ $\quad\log b = 7.4959306-10$

$c = -0.000001116585$ $\quad\log c = 4.0666447_n-10$

$$h = \frac{12.25275}{\Sigma(1-\beta\cos 2\varphi)}(m'-m) + \frac{0.0031329}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^2 - \frac{0.0000001166}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^3.$$

Indsættes i Ligningerne Værdierne af a, b og c faaes

Substituting into the equations the values of a, b, and c, we get

No.	Ber. h (*Comp.*)	Obs. h	$O - B$
1	90.0 Fv. (*Fms.*)	93 Fv. (*Fms.*)	+3.0 Fv. (*Fms.*)
2	416.8	416	−0.8
3	1217.8	1216	−1.8
4	1279.3	1280	+0.7
5	1334.7	1333	−1.7
6	1340.5	1343	+2.5
7	1484.3	1487	+2.7
8	1594.5	1590	−4.5
9	1683.7	1686	+2.3
10	1985.2	1985	−0.2
			M. F. ± 2.02

Den sandsynlige Fejl af 1 Obs.: $\delta = \pm 1.91$ Favn. Den empiriske Formel tilfredsstiller altsaa Observationerne fuldkommen saa godt som den fysiske ($\delta = \pm 1.94$)

Man faar af Formelen

The probable error of 1 observation $\delta = \pm 1.91$ fathom. Hence the empirical formula satisfies the observations quite as well as the physical ($\delta = \pm 1.94$).

We get from the formula

$$\frac{dh}{d(m'-m)} = \frac{12.25275}{\Sigma(1-\beta\cos 2\varphi)} + \frac{0.0062658}{\Sigma(1-\beta\cos 2\varphi)}(m'-m) - \frac{0.000003498}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^2.$$

Sættes som ovenfor $d(m'-m) = 0.081$ mm,

faar man $dh = \frac{0.994 + 0.0005(m'-m)}{\Sigma(1-\beta\cos 2\varphi)}$,

en Størrelse, der, mellem Overfladen og 2000 Favne, holder sig mellem 0.964 og 1.110 Favn. Med Piezometret og den empiriske Formel faar man altsaa Dybderne paa $\pm$ 1 Fv.

Putting as before $d(m'-m) = 0.081$ mm.,

we have $dh = \frac{0.994 + 0.0005(m'-m)}{\Sigma(1-\beta\cos 2\varphi)}$.

a quantity that ranges, between the surface and 2000 fathoms, from 0.964 to 1.110 fathom. With the piezometer and the empirical formula, we can, therefore, determine the depth within $\pm$ 1 fathom.

I den empiriske Formel er intet Hensyn taget til at Vandets Sammentrykkelighed er afhængig af Temperaturen. Det rene Vands Sammentrykkeligheds Variation med Temperaturen samt Havvandets Sammentrykkelighed og dens Variation med Temperaturen, gaar, da Temperaturen i Regelen aftager med Dybden, ind i Coefficienterne for $(m'-m)^2$ og $(m'-m)^3$. Formelen indeslutter en midlere Værdi af η, passende for de høje Bredder i vort Nordhav.

Sætter man, for at tage Hensyn til Temperaturens Indflydelse paa Vandets Sammentrykning i Piezometret, Ligningen for Dybden under Formen:

In the empirical formula, no regard has been taken to the compressibility of water being dependent on temperature. The variation in compressibility of pure water with temperature, as also the compressibility of sea-water and its variation with temperature, will, the temperature decreasing as a rule with depth, be included in the coefficients for $(m'-m)^2$ and $(m'-m)^3$. The formula involves a mean value of η adapted to the high latitudes of our North Ocean.

If, that regard may be had to the influence of temperature on the compression of the water in the piezometer, we put the equation for depth under the form

$$\Sigma(1-\beta\cos 2\varphi)\,h = a(1+qt)(m'-m) + b(m'-m)^2 + c(m'-m)^3,$$

idet Sammentrykkelighedscoefficienten ($\eta_t = \eta_0(1-qt)$) forekommer i Nævneren af Coefficienten til $(m'-m)$, har man

the coefficient of compression ($\eta_t = \eta_0(1-qt)$) occurring in the numerator of the coefficient of $(m'-m)$, we have

$$q = \frac{0.1590}{50.153} = 0.0031702; \quad \log q = 7.50109-10.$$

Man faar da følgende Værdier for log (Coeff. t. a)

We then get the following values for log (coeff. for a): —

No.	t	qt	$\log.\frac{(1+qt)(m'-m)}{\Sigma(1-\beta\cos 2\varphi)}$
1	2°.6	+0.00824	0.86847
2	0 .77	+ 244	1.52893
3	−1 .35	−0.00428	1.98491
4	−1 .37	− 434	2.00580
5	−1 .42	− 450	2.02370
6	−1 .29	− 409	2.02574
7	−1 .53	− 485	2.06850
8	−1 .47	− 466	2.09883
9	−1 .53	− 485	2.12173
10	−1 .50	− 378	2.19148

Factorerne b, c og h blive de samme som ovenfor. Endeligningerne blive:

The factors b, c, and h will be the same as above. The normal equations are

$$\begin{aligned}
114352.\,a + 14557772.\,b + 1904468269.\,c &= 1450564\\
14557772.\,a + 1912740543.\,b + 257081182958.\,c &= 184843697\\
1904468269.\,a + 257081182958.\,b + 35422403423676.\,c &= 24200418357
\end{aligned}$$

hvoraf (*whence*) $a = 12.089666$ $\quad\log a = 1.0824143$

$b = 0.00660055$ $\quad\log b = 7.8195832-10$

$c = -0.000014704$ $\quad\log c = 5.1674405_n-10.$

Indsættes Værdierne af a, b og c i Ligningerne, faaes:

Substituting the values of a, b and c into the equations, we get: —

No.	$a \frac{(1+qt)(m'-m)}{\Sigma(1-\beta\cos 2\varphi)}$	$b(m'-m)^2$	$c(m'-m)^3$	ber. h	obs. h.	$O-B$
1	89.31	+ 0.36	−0.01	89.7	93	+3.3 Fv. (*Fms.*)
2	408.64	7.73	0.60	415.8	416	+0.2
3	1167.67	63.97	14.24	1217.4	1216	−1.4
4	1225.21	70.44	16.45	1279.2	1280	+0.8
5	1276.76	76.53	18.63	1334.7	1333	−1.7
6	1282.77	77.19	18.87	1341.1	1343	+1.9
7	1415.50	94.13	25.42	1484.2	1487	+2.8
8	1517.89	108.19	31.32	1594.8	1590	−4.8
9	1600.07	120.27	36.71	1683.6	1686	+2.4
10	1878.84	165.45	−59.22	1985.1	1985	−0.1

M. F. = ± 1.94

$\delta = \pm 1.794$ Favn. (*Fms.*)

Denne Formel giver saaledes en endnu mindre sandsynlig Fejl end den forrige. Rækkens Convergents er imidlertid bleven adskillig mindre, idet i den forrige Formel Leddet $c(m'-m)^3$ i Ligning No. 10 kun er −4.7 Favne.

This formula gives accordingly a probable error still smaller than the preceding. The convergence of the series, however, has become considerably less, the term of the first formula. $c(m'-m)^3$, in equation No. 10, being but −4.7 fathoms.

Efter Formelen faar man:

According to the formula, we get: —

$$\frac{dh}{d(m'-m)} = \frac{12.089666(1+qt)}{\Sigma(1-\beta\cos 2\varphi)} + \frac{0.01320110}{\Sigma(1-\beta\cos 2\varphi)}(m'-m) - \frac{0.00014112}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^2.$$

Sættes (*Putting*) $d(m'-m) = \pm 0.081$

faaes (*we get*) $$dh = \frac{0.9793(1+qt)}{\Sigma(1-\beta\cos 2\varphi)} + \frac{0.001069}{\Sigma(1-\beta\cos 2\varphi)}(m'-m) - \frac{0.000003573}{\Sigma(1-\beta\cos 2\varphi)}(m'-m)^2.$$

en Størrelse, der mellem Overfladen og 2000 Favnes Dyb varierer fra 0.967 til 1.028 Favn.

Efter Rækkeudviklingen af den rationelle Formel bliver

a quantity that varies, between the surface and a depth of 2000 fathoms, from 0.967 to 1.028 fathom.

According to the rational formula developed in a series, we have

$$\Sigma(1-\beta\cos 2\varphi)h = \frac{1}{a_0\left(\frac{C}{c}-m\right)\iota_0}(m'-m) + \ldots = \frac{1}{a_0\left(\frac{C}{c}-m\right)\iota_0(1-qt)} = \frac{(1+qt)}{a_0\left(\frac{C}{c}-m\right)\iota_0} + \ldots$$

Indsættes her Værdierne $a_0 = 0.1769851$, $\iota_0 = 50.153$ Milliontedele, $\frac{C}{c} = 9303.07$ og Middeltallet af $m = 10.5661$, faar man Factoren lig $12.1236(1+qt)$, altsaa meget nær lig den af den sidste empiriske Formel fremgaaende. Undersøger man, hvad Værdi den empiriske Formel giver for Factoren c, saa findes $c = 0.00045472$. Buchanan's Bestemmelse, med hvilken der er regnet i den rationelle Formel, er 0.000456.

Substituting here the values $a_0 = 0.1769851$, $\iota_0 = 50.153$ millionths, $\frac{C}{c} = 9303.07$, and the mean for $m = 10.5661$, we get the factor equal to $12.1236(1+qt)$, therefore very nearly equal to that deduced from the last empirical formula. If we investigate what value the empirical formula gives to the factor c, we shall find $c = 0.00045472$. Buchanan's determination, with which I have computed in the rational formula, is 0.000456.

Indleveret Marts 1886.

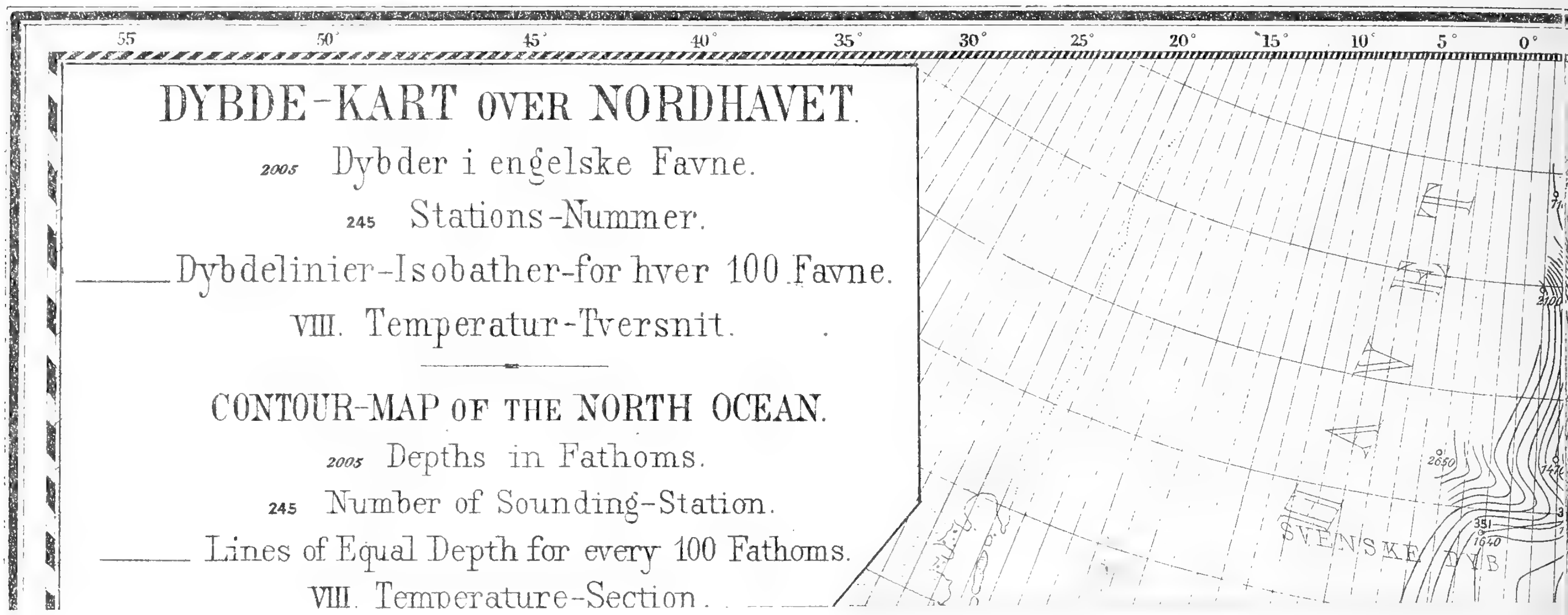
Received March 1886.

Translated into English by **J. Hazeland**.

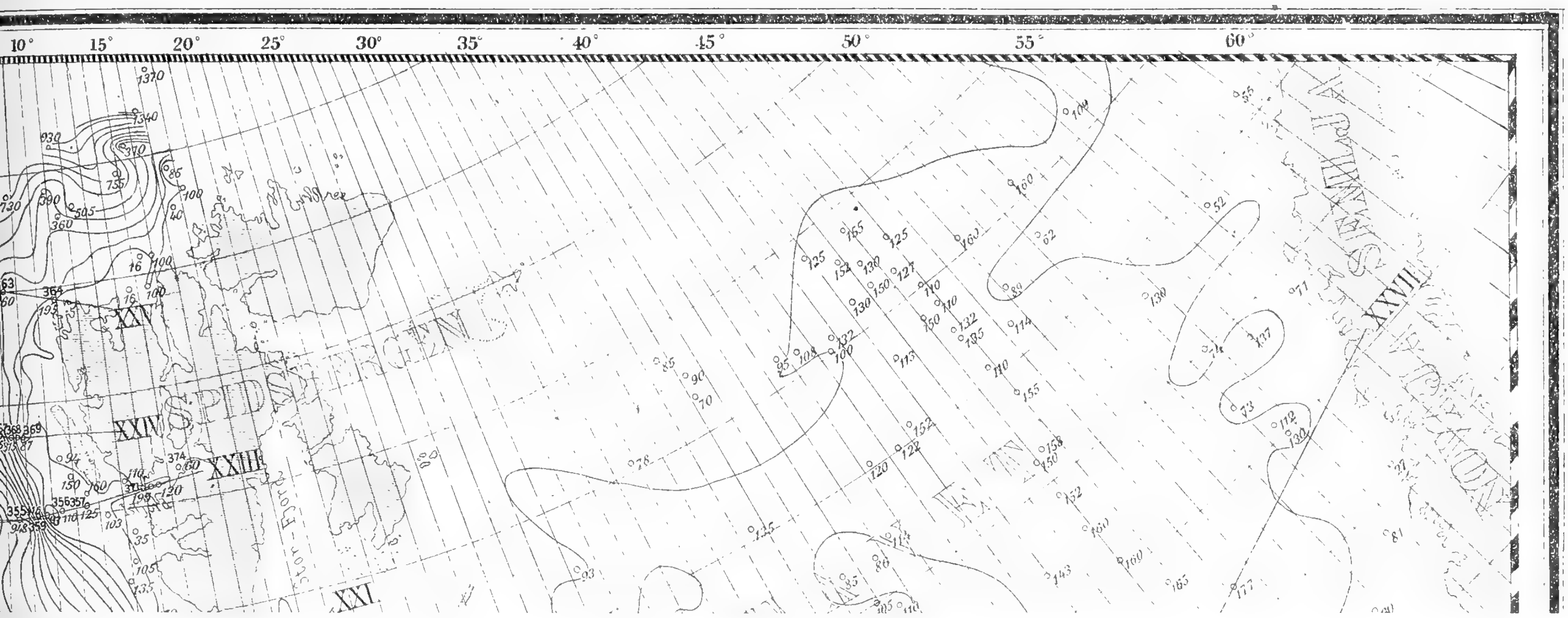
Plader.

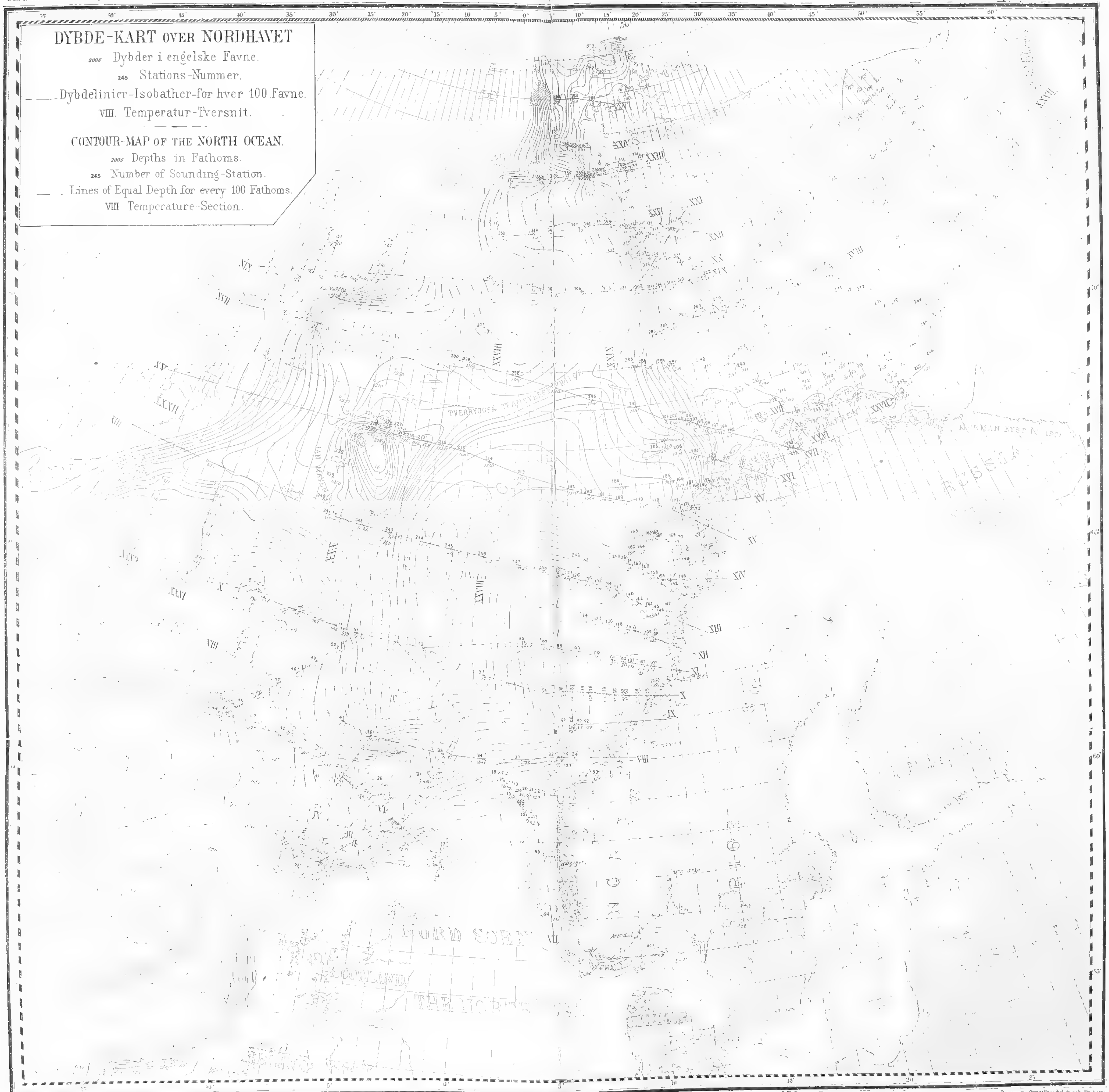
Plates.

Den Norske Nordhavs-Expedition. H. Mohn. *Nordhavets Dybder, Temperatur og Strömninger.*

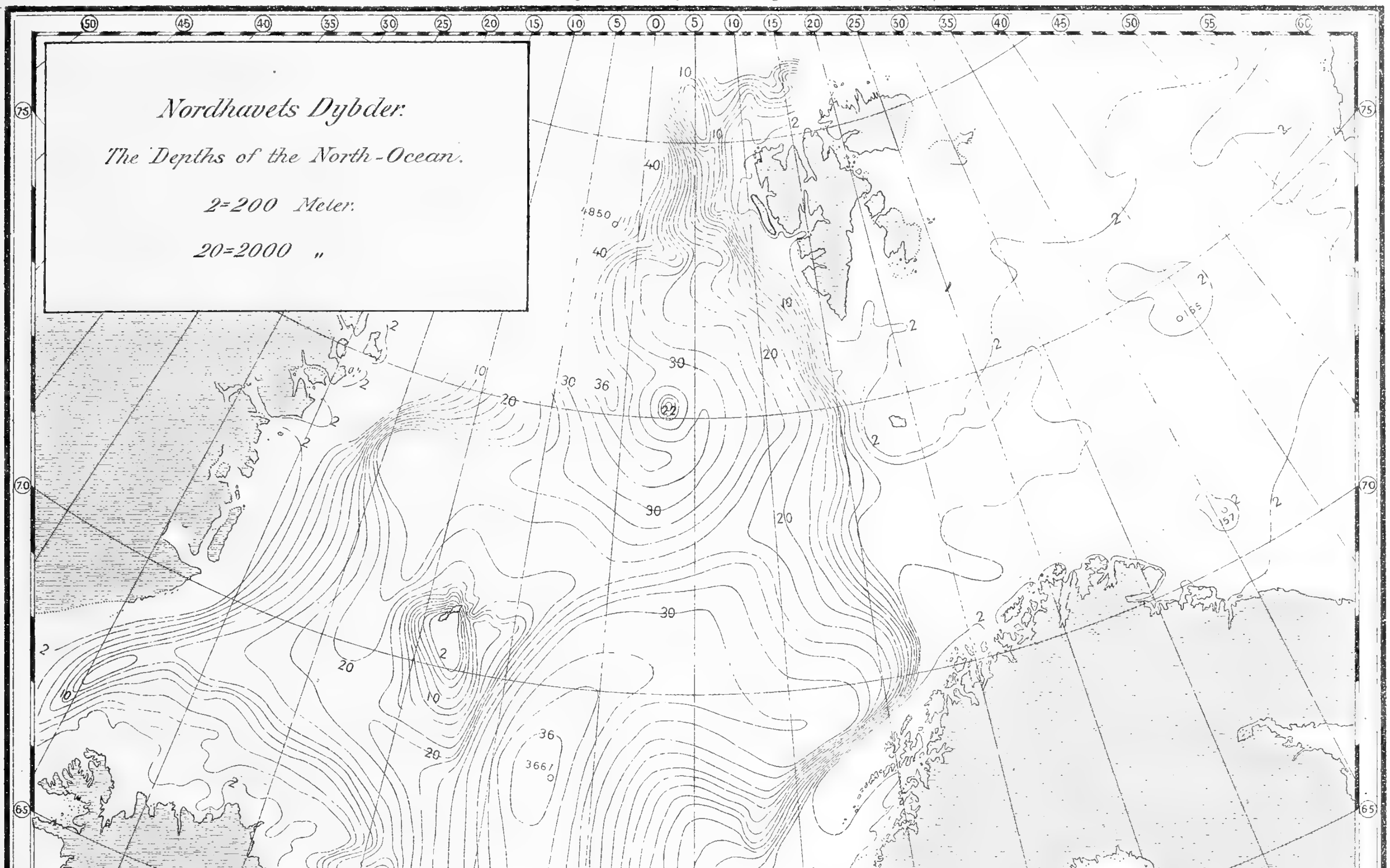


Pl. I.

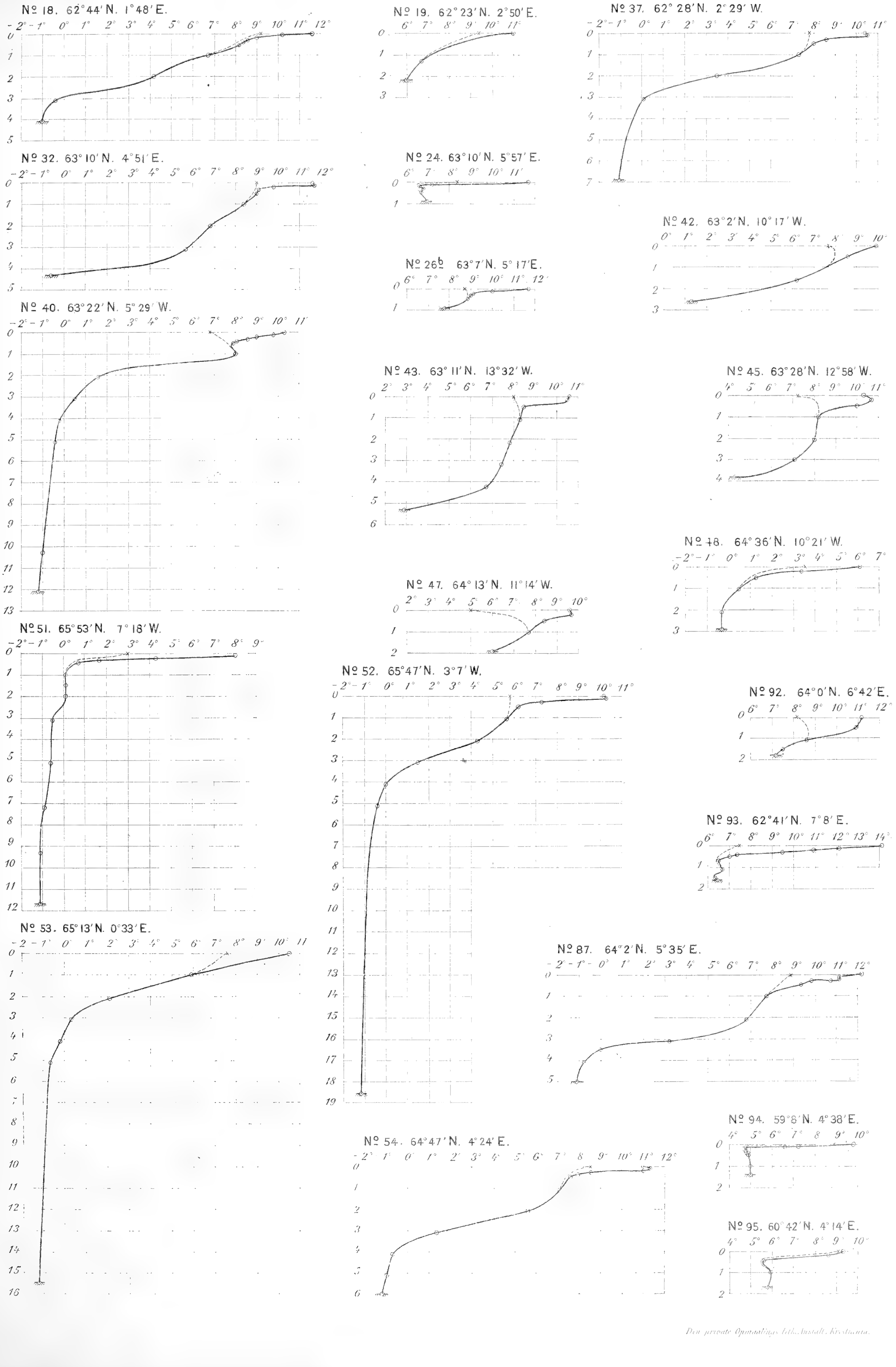




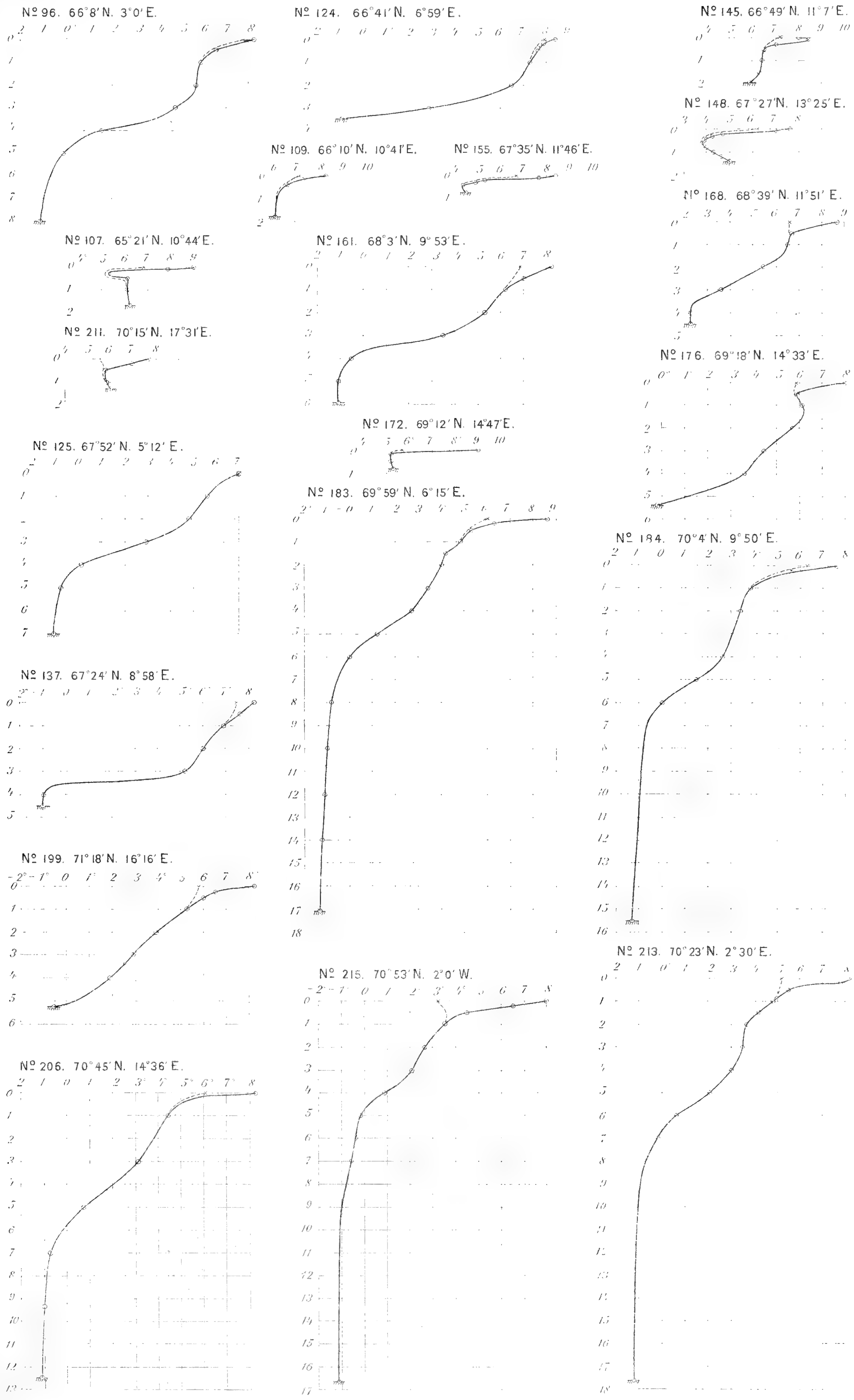
Maalestok 1: 7000000.

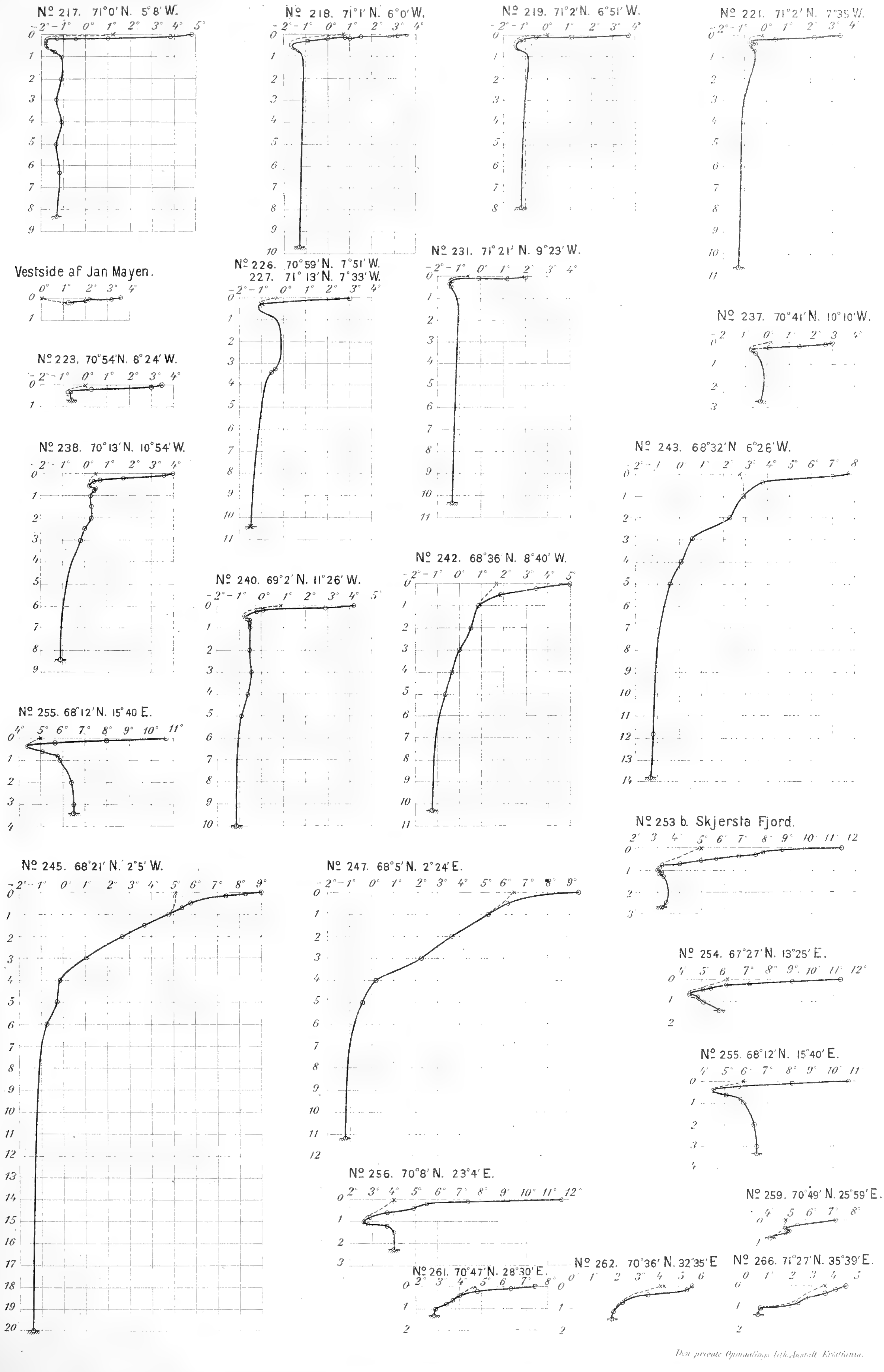


Den private Opmaalings lith. Anstalt, Kristiania.

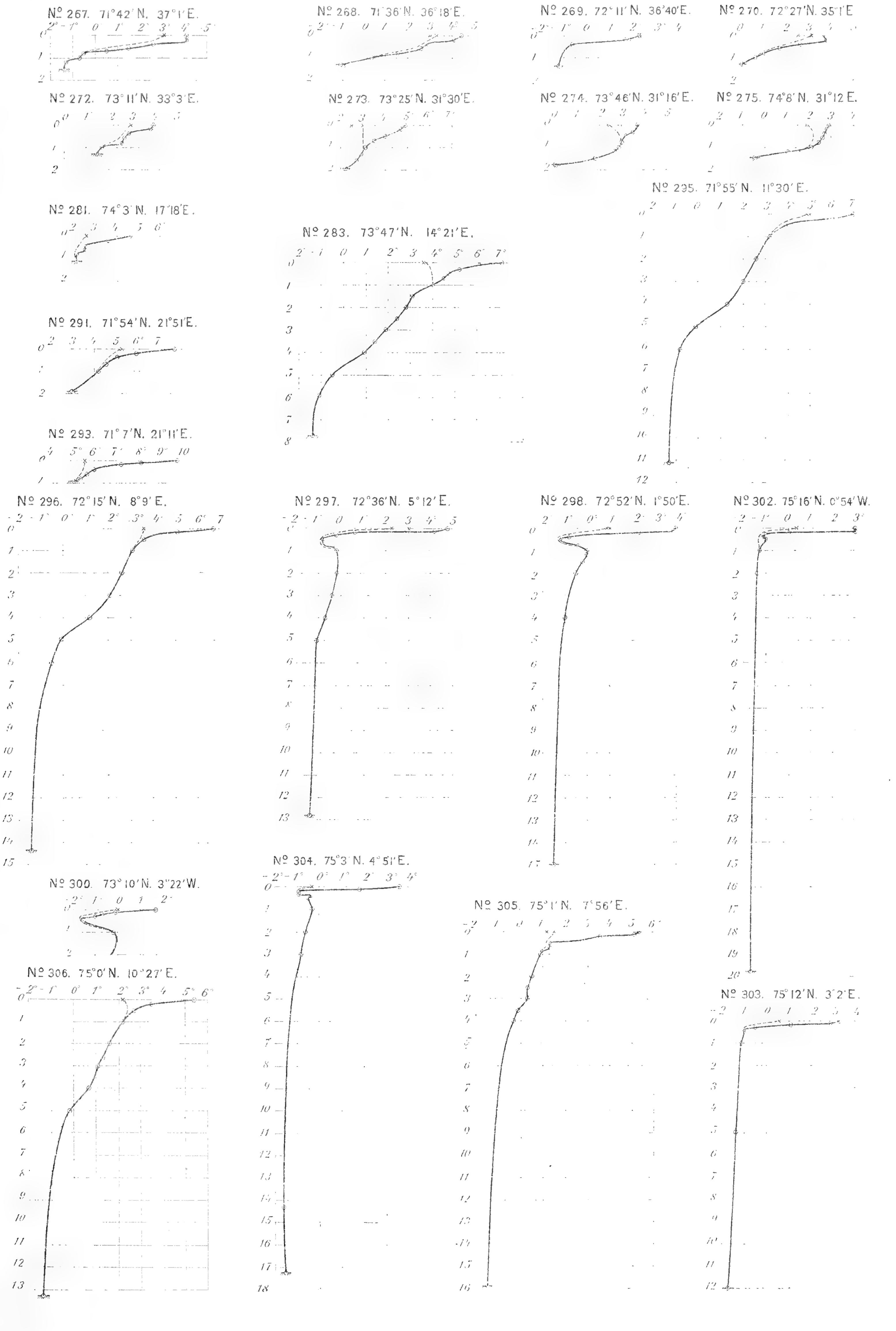


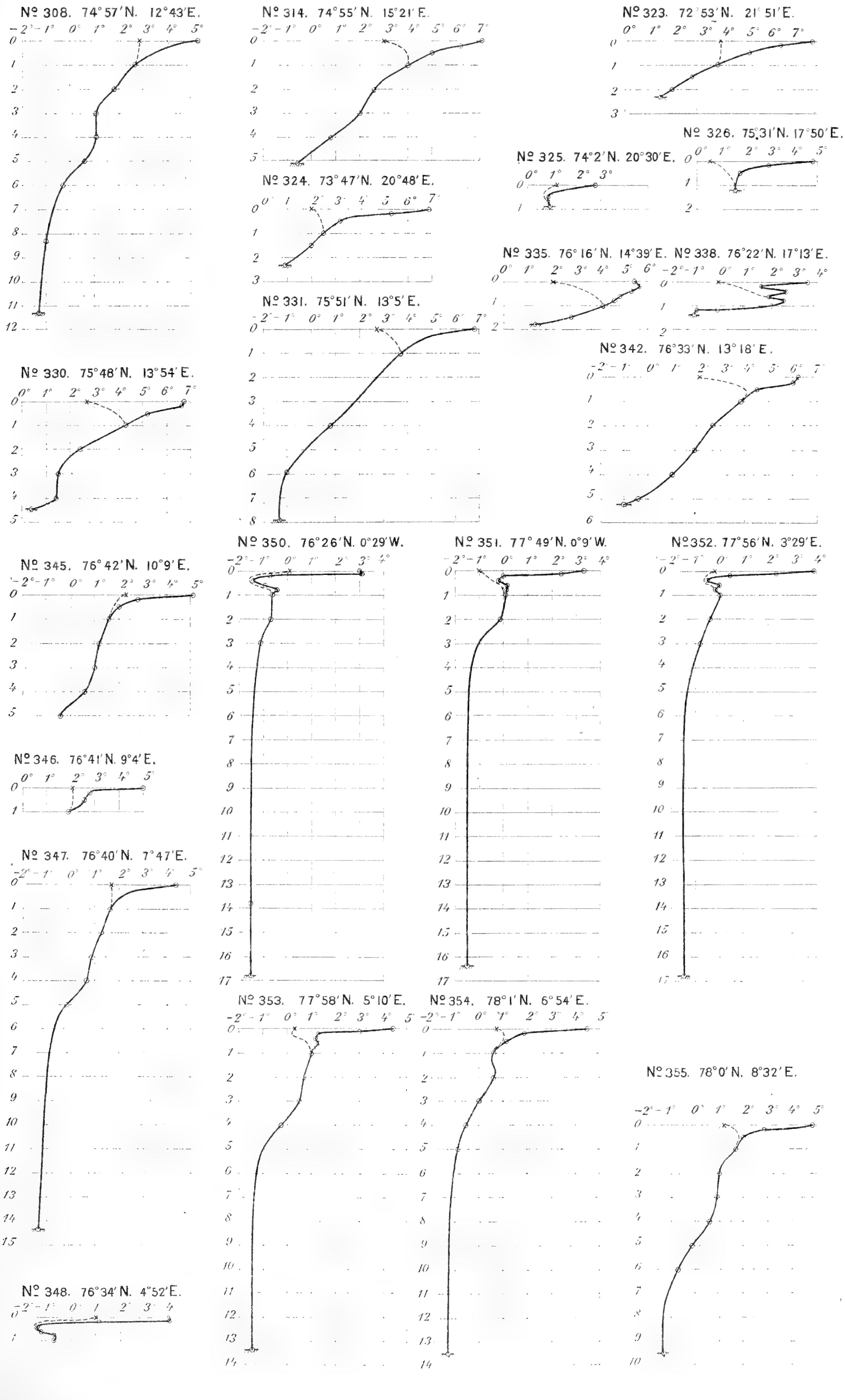
Den private Opmaalings lith. Anstalt, Kristiania.

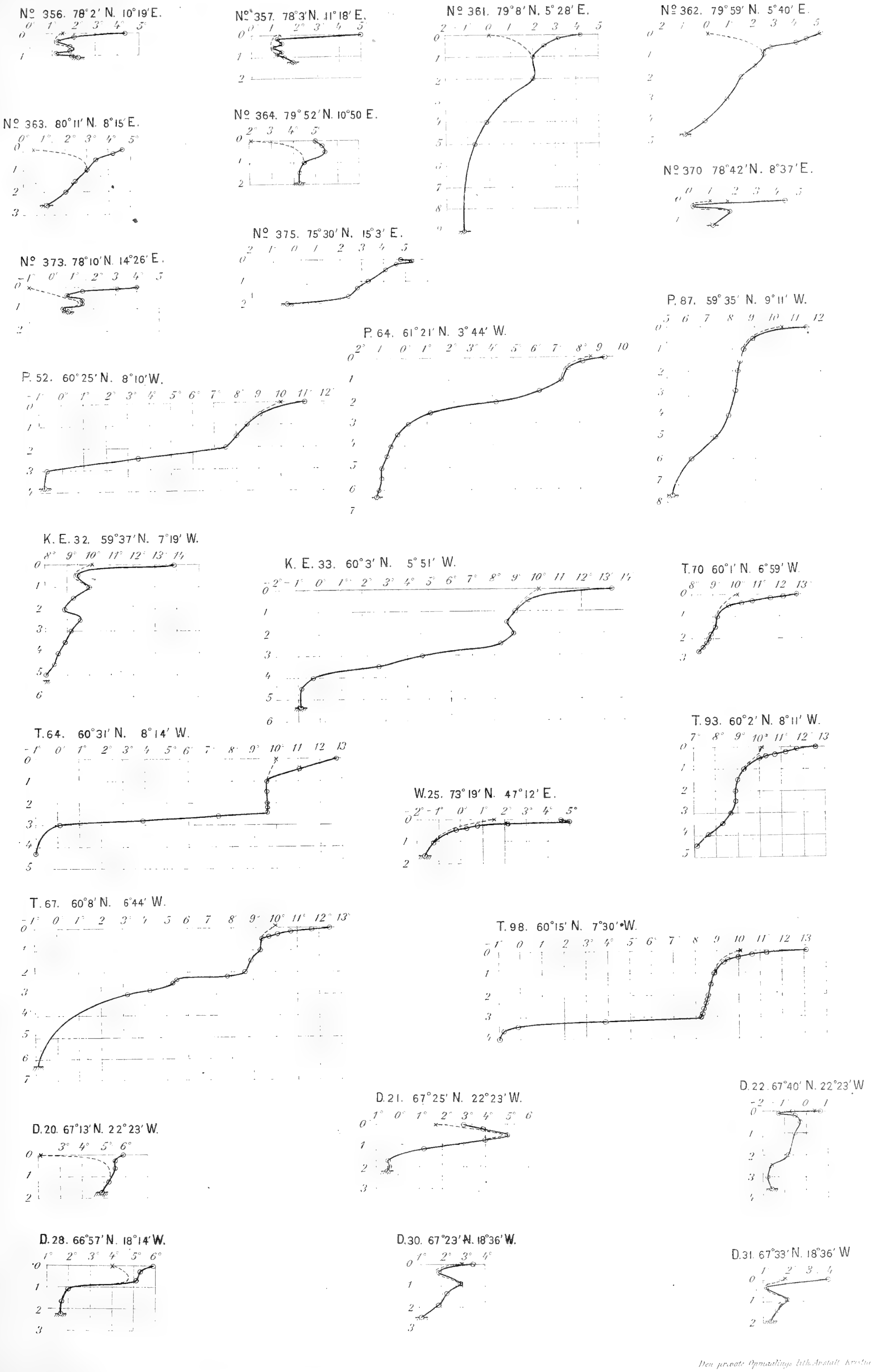

Nº 96. 66°8'N. 3°0'E.
Nº 124. 66°41'N. 6°59'E.
Nº 145. 66°49'N. 11°7'E.
Nº 148. 67°27'N. 13°25'E.
Nº 109. 66°10'N. 10°41'E.
Nº 155. 67°35'N. 11°46'E.
Nº 168. 68°39'N. 11°51'E.
Nº 107. 65°21'N. 10°44'E.
Nº 161. 68°3'N. 9°53'E.
Nº 211. 70°15'N. 17°31'E.
Nº 176. 69°18'N. 14°33'E.
Nº 172. 69°12'N. 14°47'E.
Nº 125. 67°52'N. 5°12'E.
Nº 183. 69°59'N. 6°15'E.
Nº 184. 70°4'N. 9°50'E.
Nº 137. 67°24'N. 8°58'E.
Nº 199. 71°18'N. 16°16'E.
Nº 213. 70°23'N. 2°30'E.
Nº 215. 70°53'N. 2°0'W.
Nº 206. 70°45'N. 14°36'E.



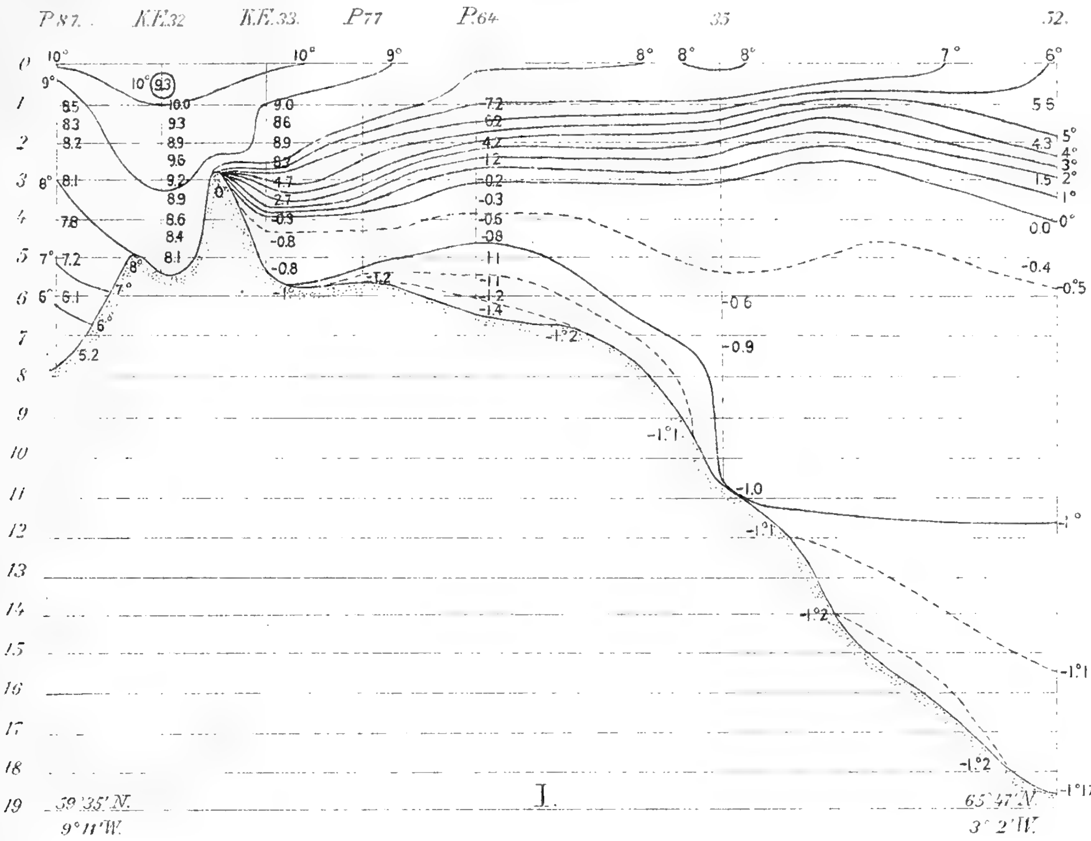
Den private Opmaalings lith. Anstalt Kristiania.

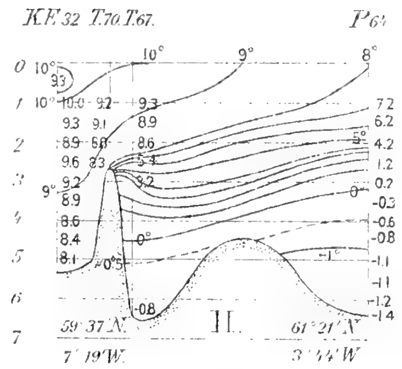

Nº 267. 71°42'N. 37°1'E.
Nº 268. 71°36'N. 36°18'E.
Nº 269. 72°11'N. 36°40'E.
Nº 270. 72°27'N. 35°1'E
Nº 272. 73°11'N. 33°3'E.
Nº 273. 73°25'N. 31°30'E.
Nº 274. 73°46'N. 31°16'E.
Nº 275. 74°8'N. 31°12 E.
Nº 281. 74°3'N. 17°18'E.
Nº 283. 73°47'N. 14°21'E.
Nº 295. 71°55'N. 11°30'E.
Nº 291. 71°54'N. 21°51'E.
Nº 293. 71°7'N. 21°11'E.
Nº 296. 72°15'N. 8°9'E.
Nº 297. 72°36'N. 5°12'E.
Nº 298. 72°52'N. 1°50'E.
Nº 302. 75°16'N. 0°54'W.
Nº 300. 73°10'N. 3°22'W.
Nº 304. 75°3'N. 4°51'E.
Nº 305. 75°1'N. 7°56'E.
Nº 306. 75°0'N. 10°27'E.
Nº 303. 75°12'N. 3°2'E.

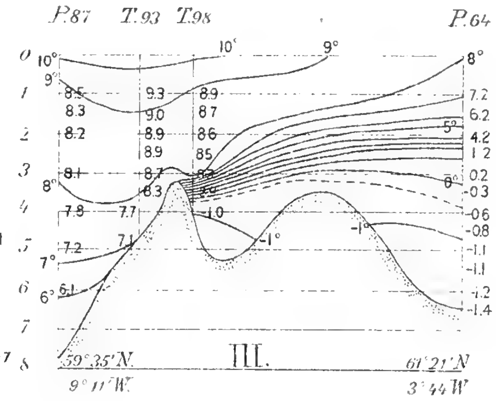

Nº 308. 74°57′N. 12°43′E.
Nº 314. 74°55′N. 15°21′E.
Nº 323. 72°53′N. 21°51′E.
Nº 326. 75°31′N. 17°50′E.
Nº 325. 74°2′N. 20°30′E.
Nº 324. 73°47′N. 20°48′E.
Nº 335. 76°16′N. 14°39′E.
Nº 338. 76°22′N. 17°13′E.
Nº 331. 75°51′N. 13°5′E.
Nº 342. 76°33′N. 13°18′E.
Nº 330. 75°48′N. 13°54′E.
Nº 350. 76°26′N. 0°29′W.
Nº 351. 77°49′N. 0°9′W.
Nº 352. 77°56′N. 3°29′E.
Nº 345. 76°42′N. 10°9′E.
Nº 346. 76°41′N. 9°4′E.
Nº 347. 76°40′N. 7°47′E.
Nº 353. 77°58′N. 5°10′E.
Nº 354. 78°1′N. 6°54′E.
Nº 355. 78°0′N. 8°32′E.
Nº 348. 76°34′N. 4°52′E.

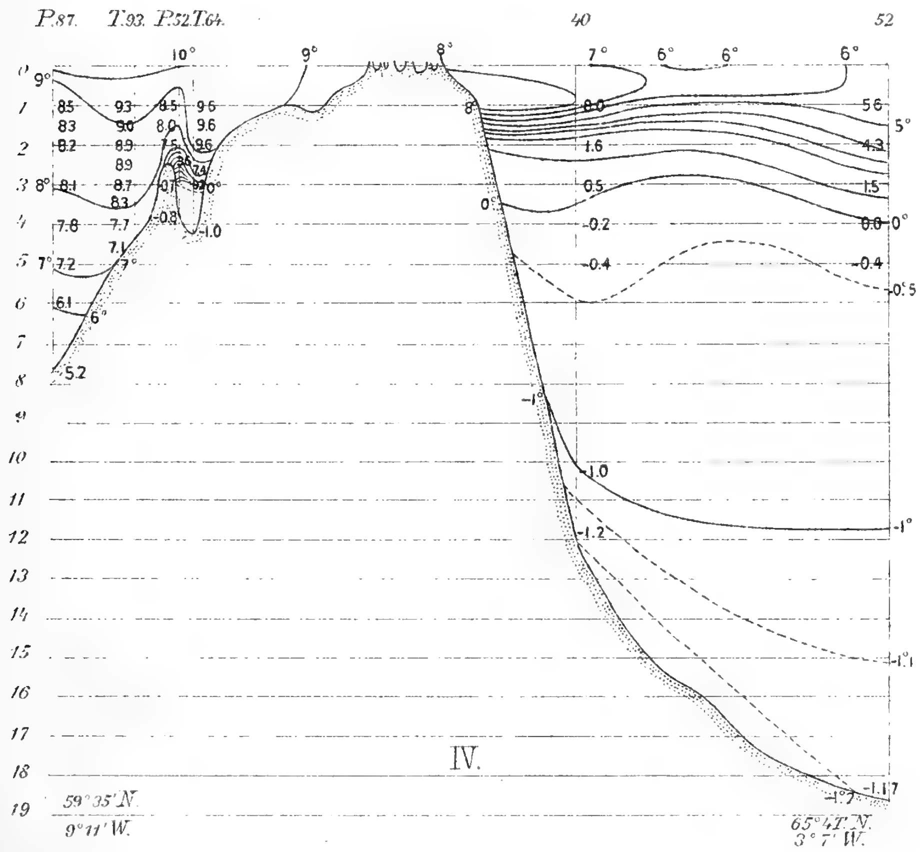


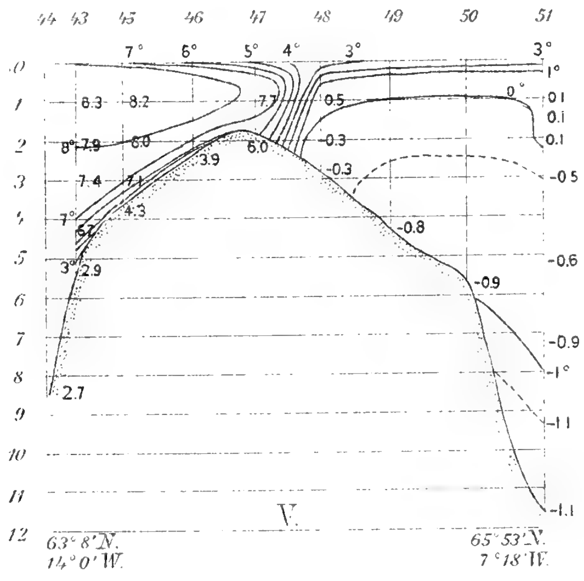
Den private Opmaalings lith. Anstalt Kristia

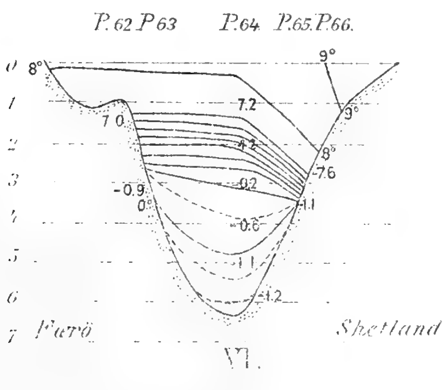

P.87. K.E.32 K.E.33. P.77 P.64 33 32.
59°35'N. 9°11'W.
65°47'N. 3°2'W.
I.

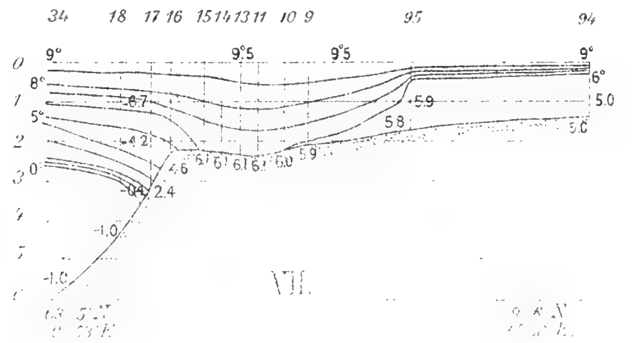

K.E.32 T.70 T.67. P.64
59°37'N. 7°19'W.
61°21'N. 3°44'W.
II.

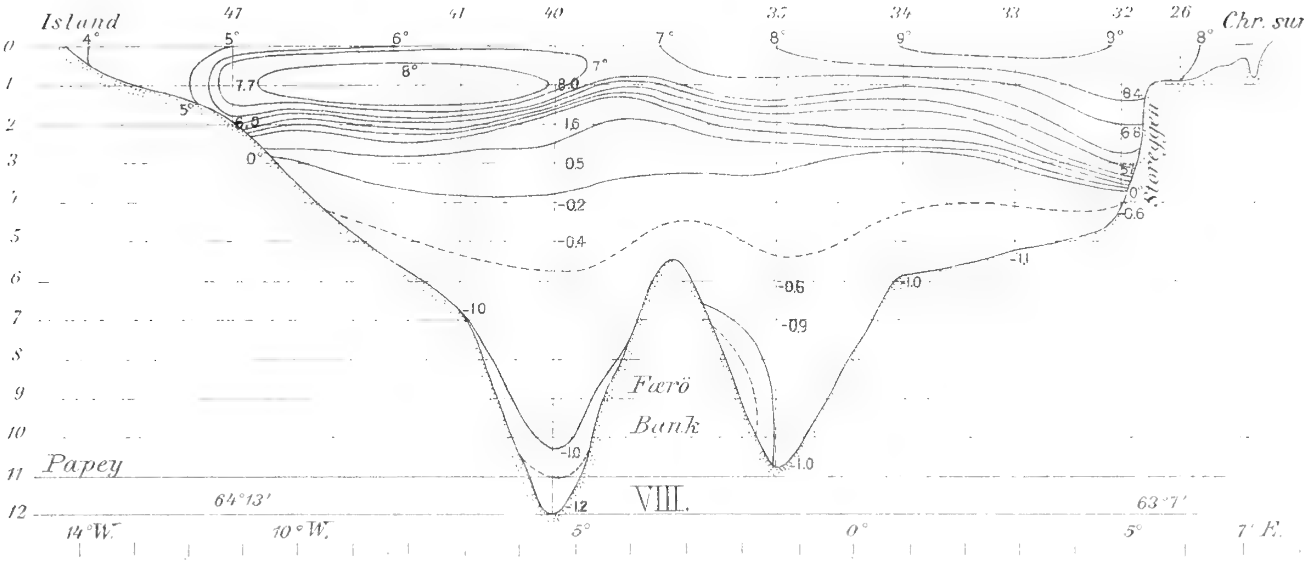

P.87 T.93 T.98 P.64
59°35'N. 9°11'W.
61°21'N. 3°44'W.
III.

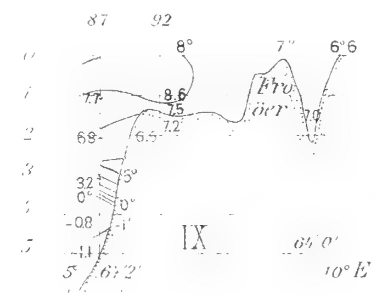

P.87. T.93. P.52 T.64. 40 52
59°35'N. 9°11'W.
65°47'N. 3°7'W.
IV.

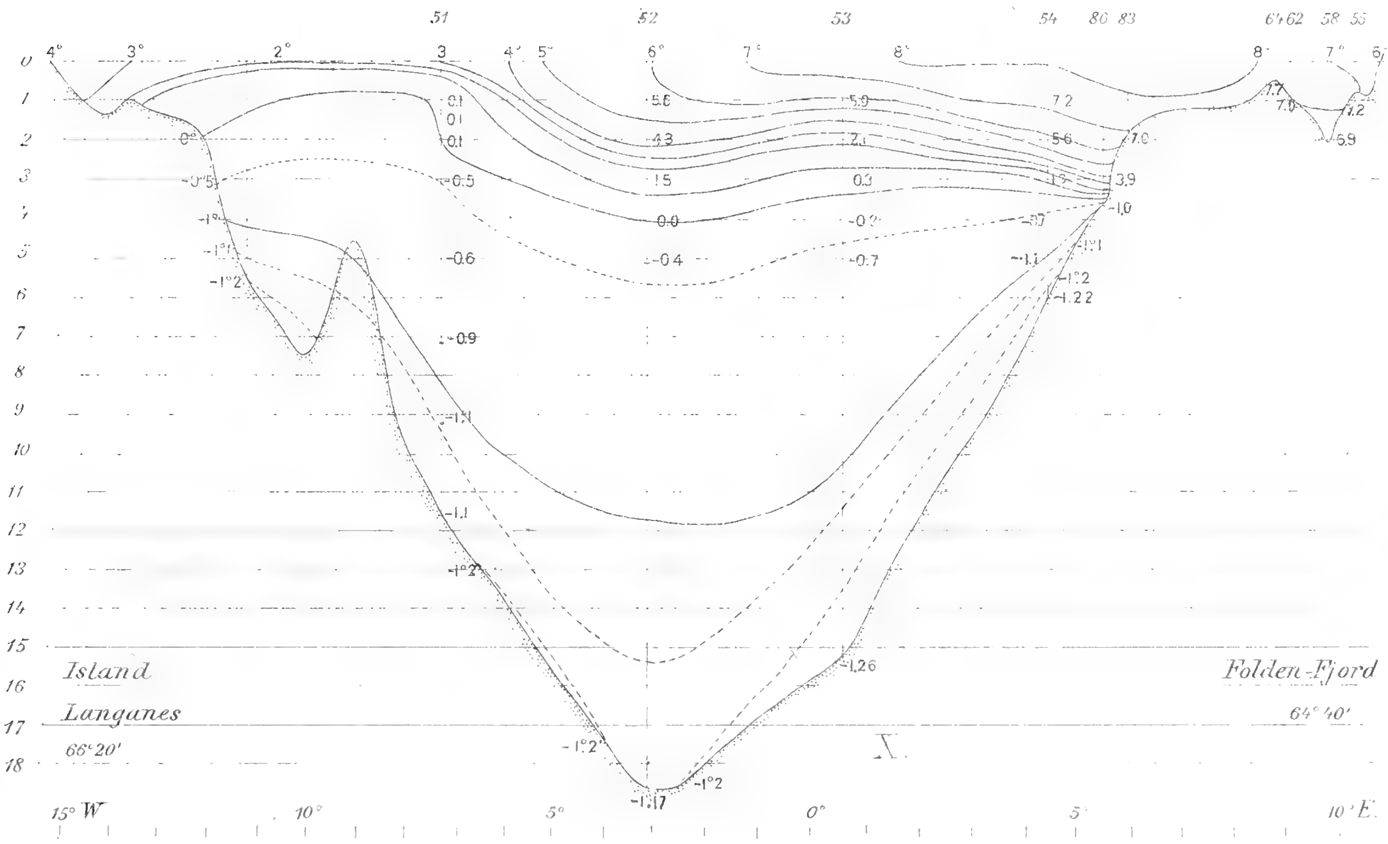

44 43 45 46 47 48 49 50 51
63°8'N. 14°0'W.
65°53'N. 7°18'W.
V.

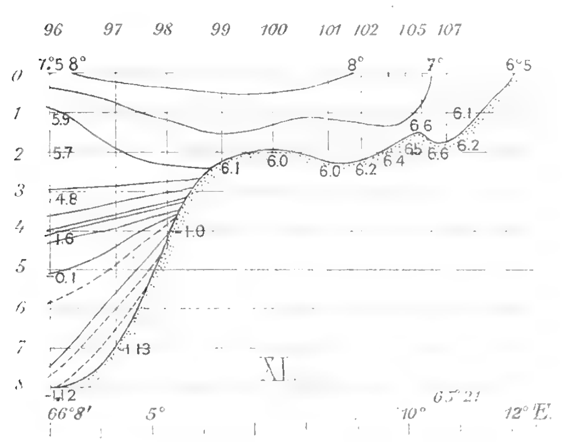

P.62 P.63 P.64 P.65 P.66.
Farö
Shetland
VI.

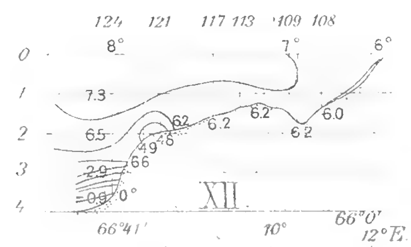

34 18 17 16 15 14 13 11 10 9 95 94
VII.

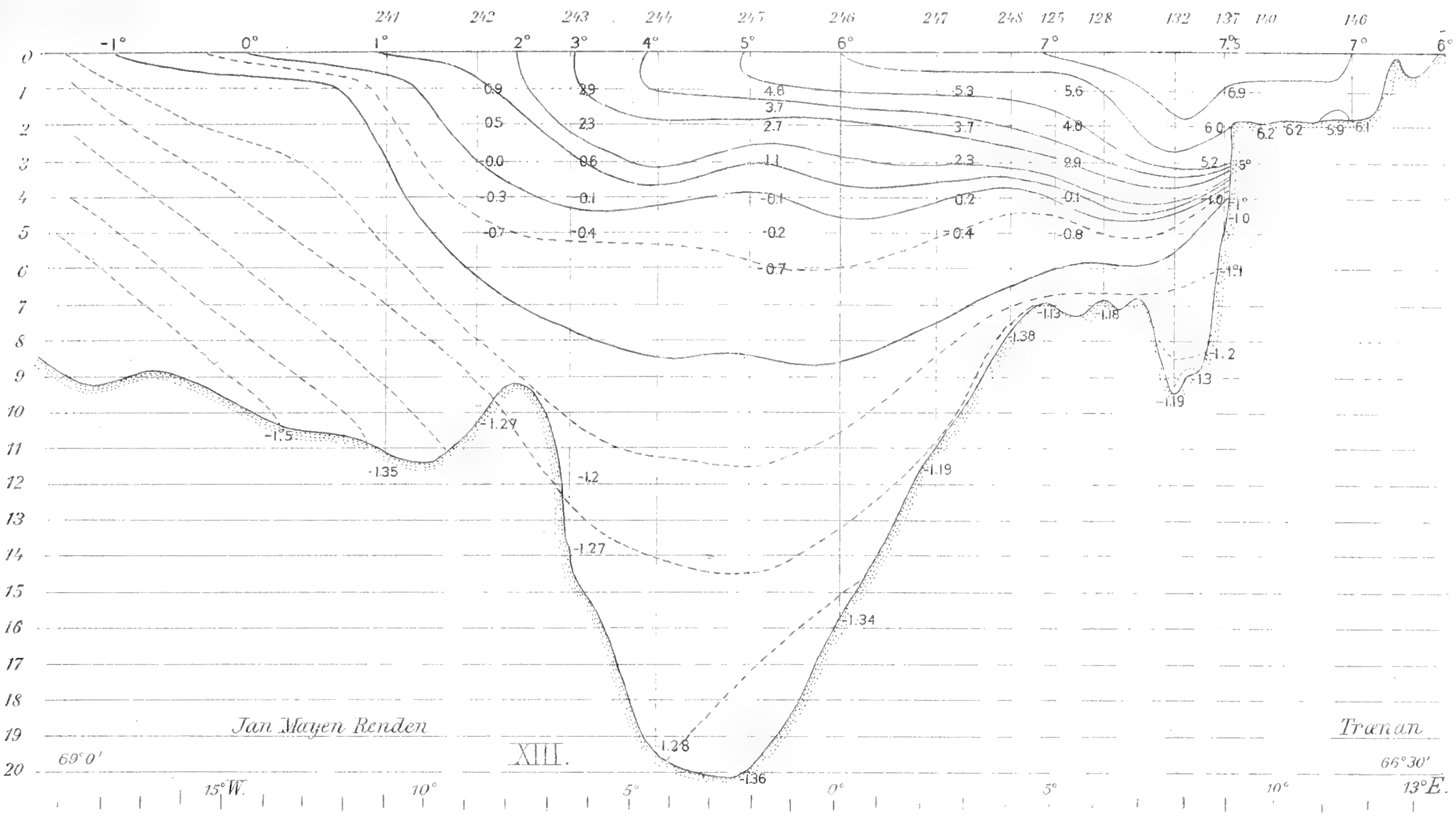

Island
Chr. sund
Storeggen
Færö Bank
Papey
VIII.
64°13'
63°7'
14°W.
10°W.
5°
0°
5°
7°E.

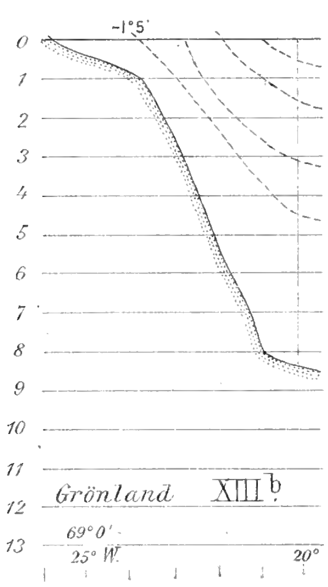

Frö öer
IX
64°0'
10°E

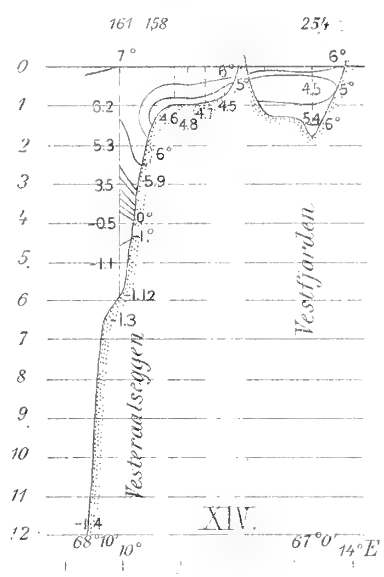

Island
Langanes
66°20'
Folden-Fjord
64°40'
X.
15°W
10°
5°
0°
5°
10°E.

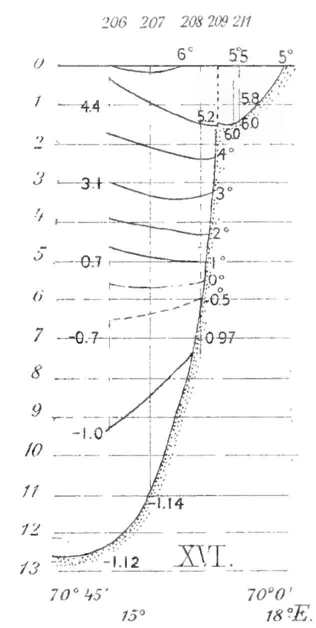

XI.
66°8'
5°
10°
65°21'
12°E.

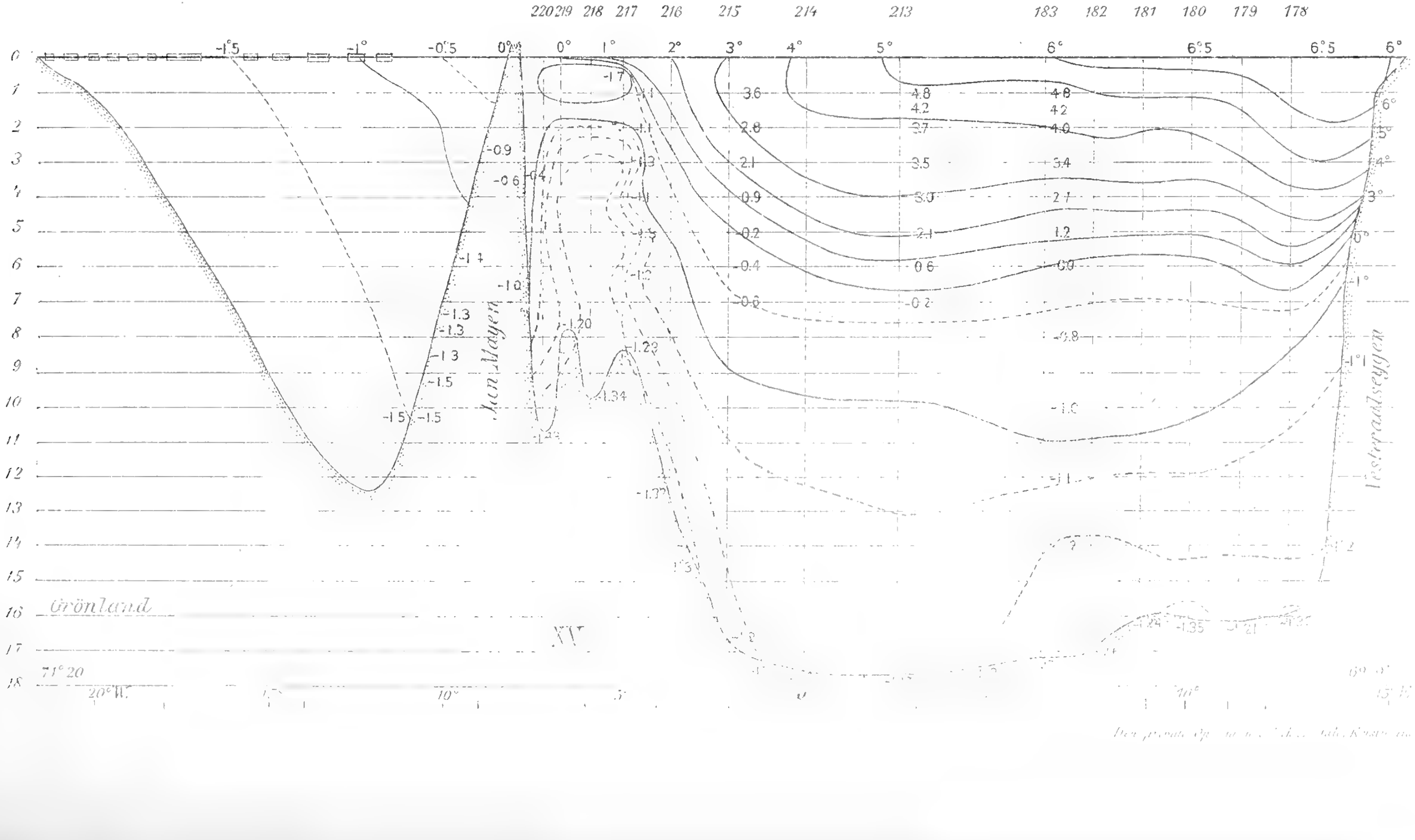

XII.
66°41'
10°
66°0'
12°E.

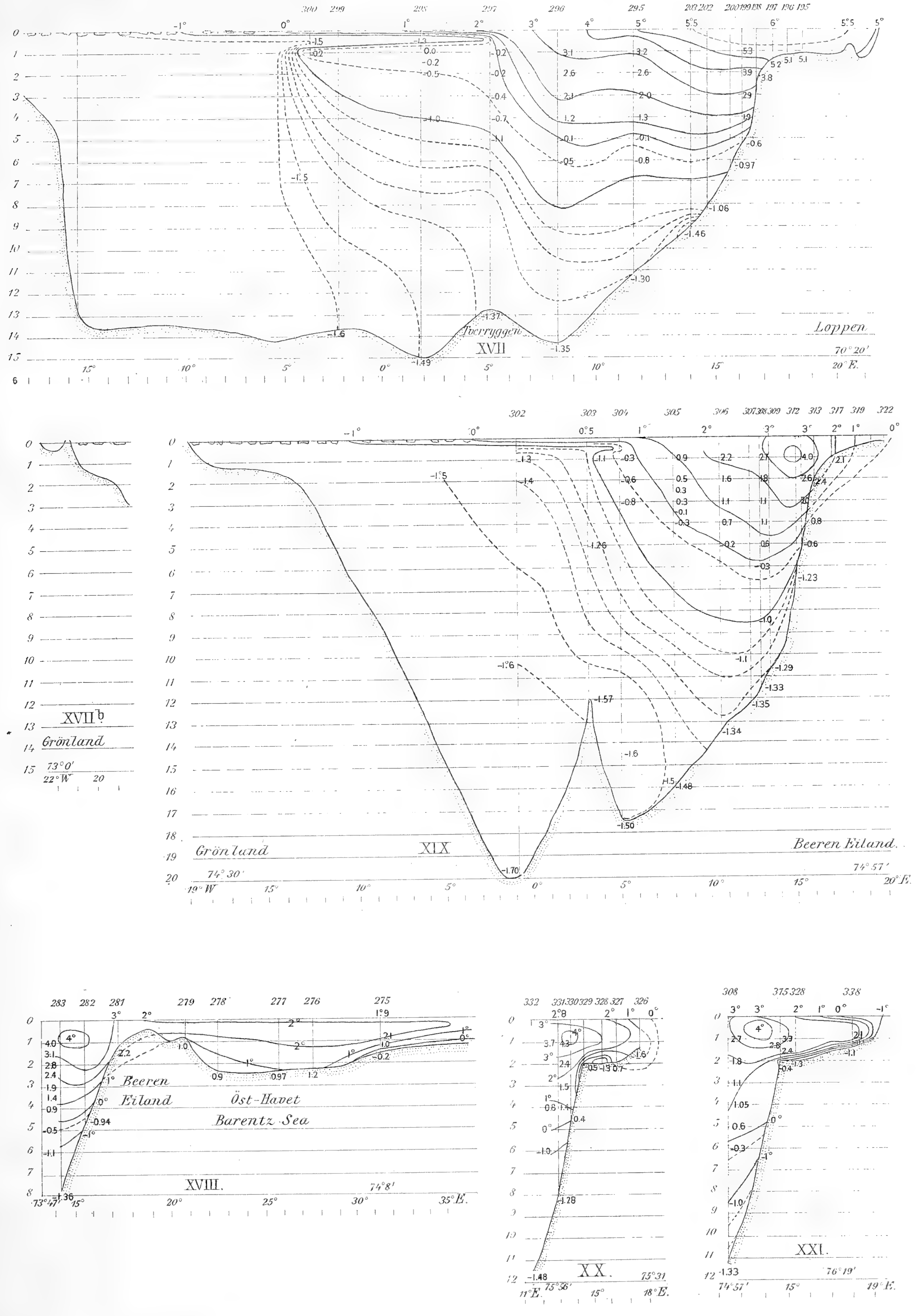

Jan Mayen Renden
Trænan
XIII.
69° 0'
66° 30'
15° W.
10°
5°
0°
5°
10°
13° E.


Grönland
XIII b
69° 0'
25° W.
20°

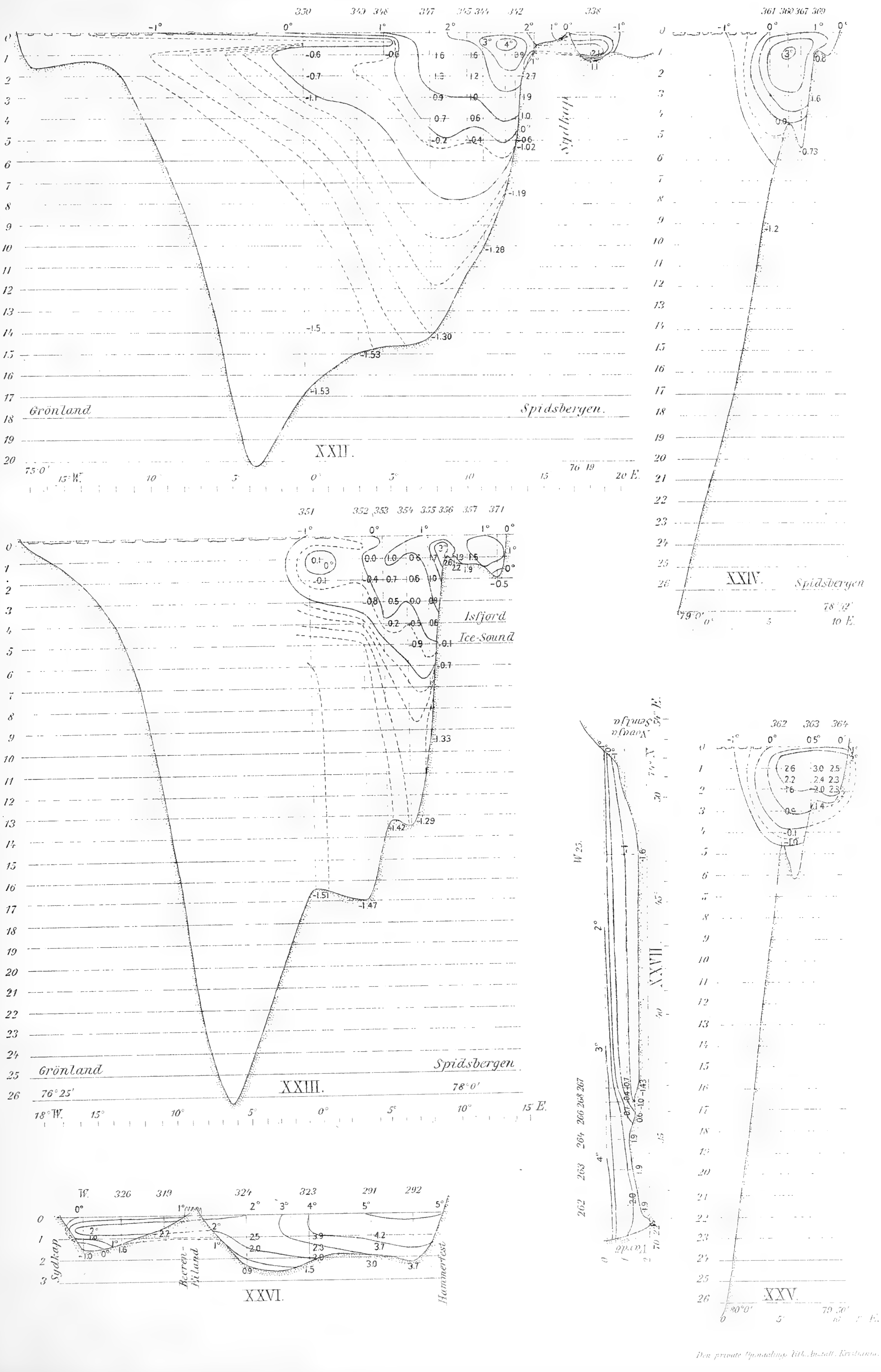

Vesteraalseggen
Vestfjorden
XIV.
68° 10'
10°
67° 0'
14° E

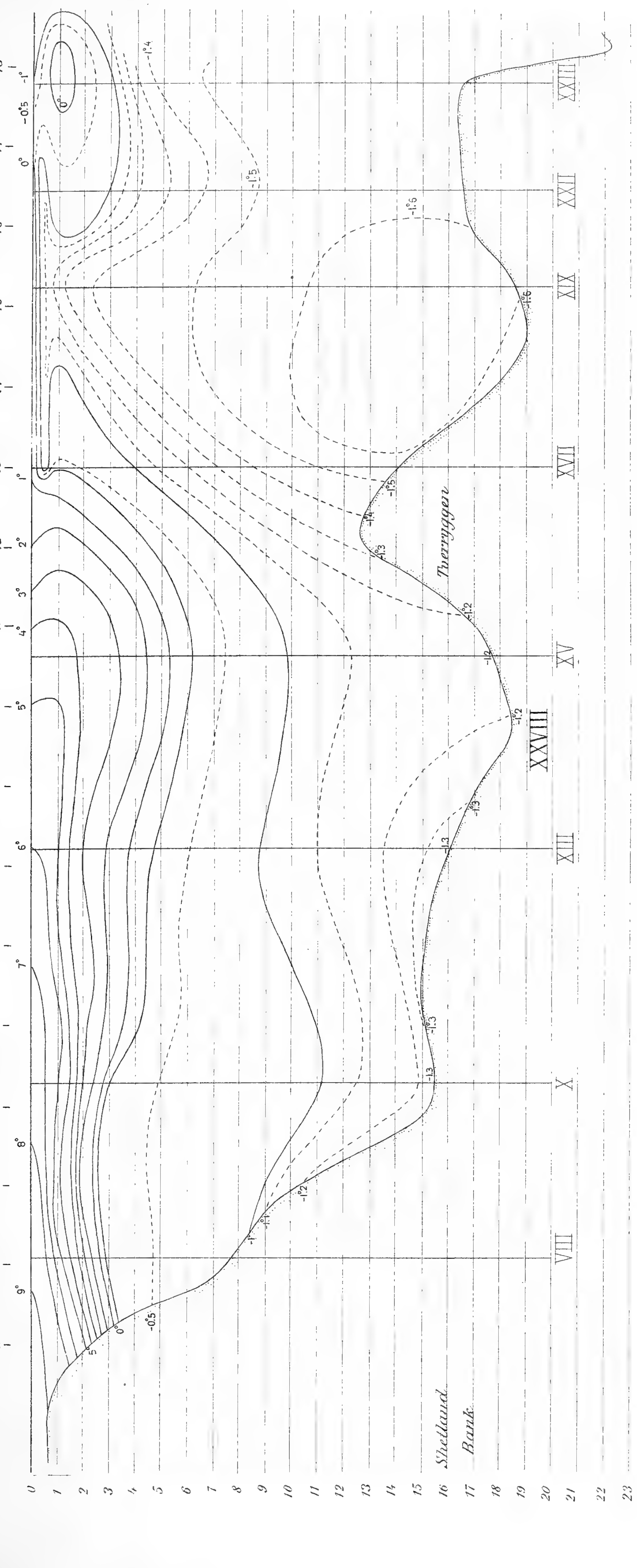

XVI.
70° 45'
15°
70° 0'
18° E.

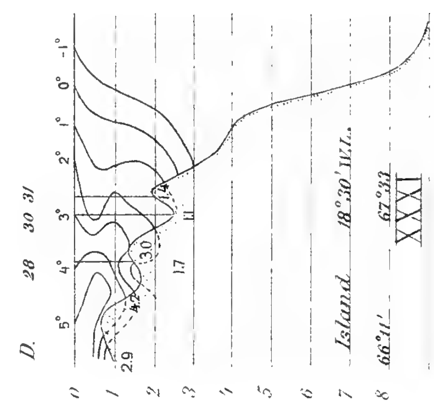

Jan Mayen
Vesteraalseggen
Grönland
XV.
71° 20
20° W.
10°

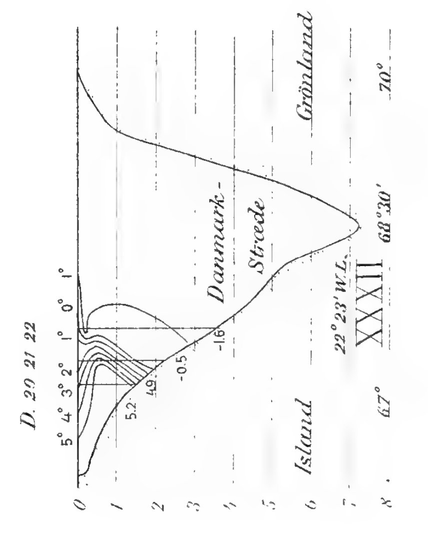


Den private Opmaalings lith. Anstalt. Kristiania.

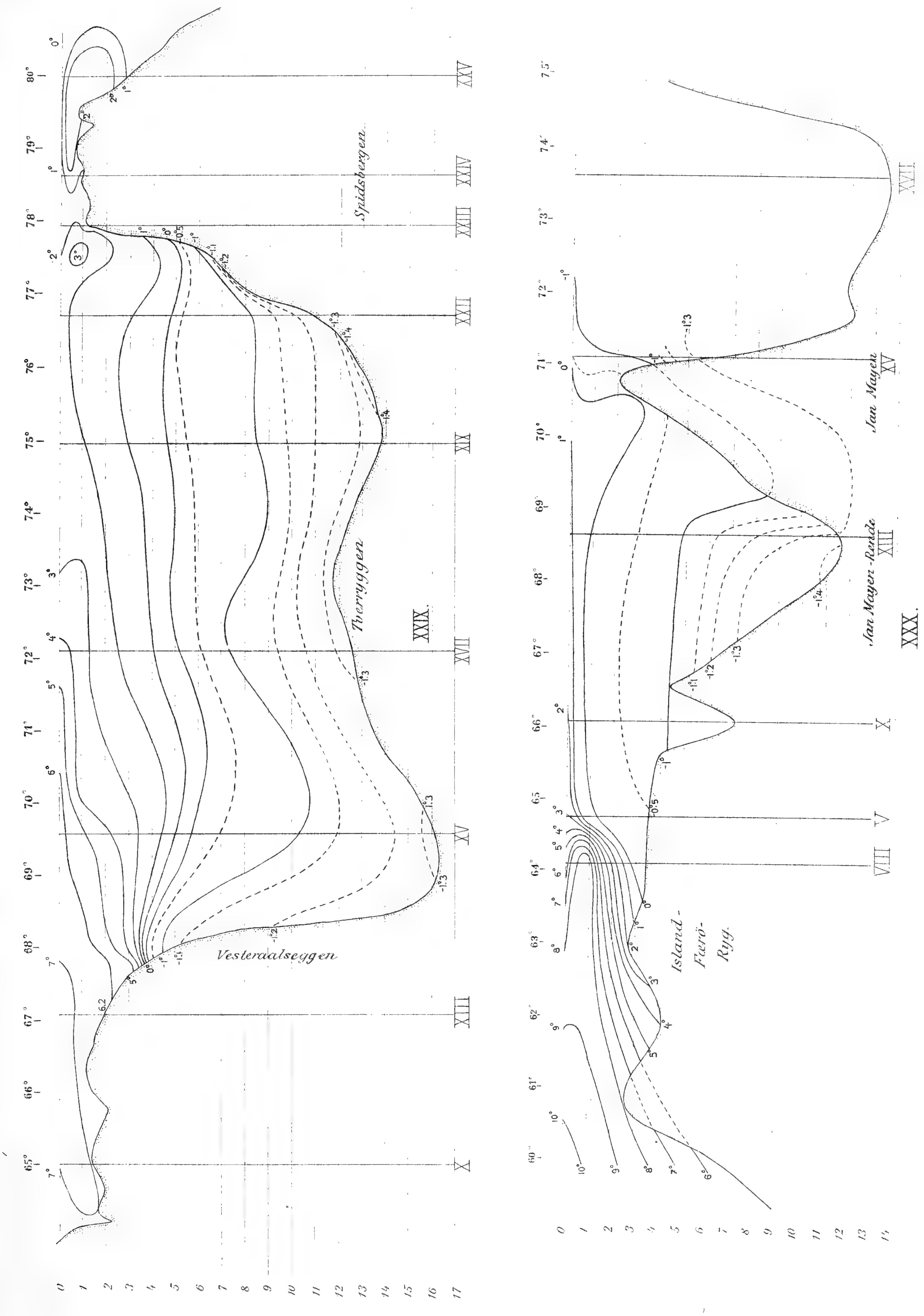

XXII.
Grönland
Spidsbergen.
XXIII.
Isfjord
Ice-Sound
XXIV.
XXV.
XXVI.
Sydkap
Beeren-Eiland
Hammerfest
XXVII.
Novaja Semlja
Vardö



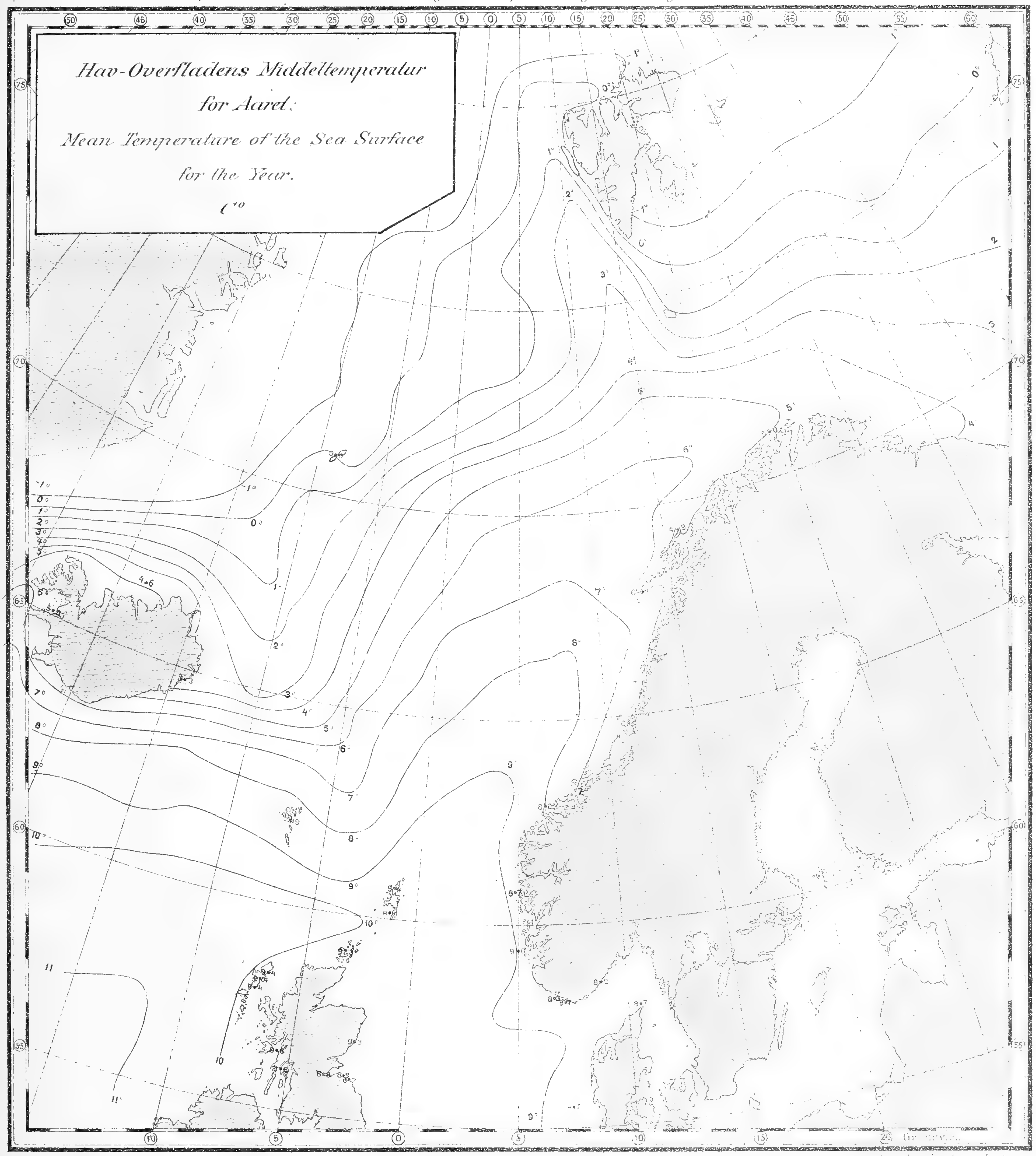


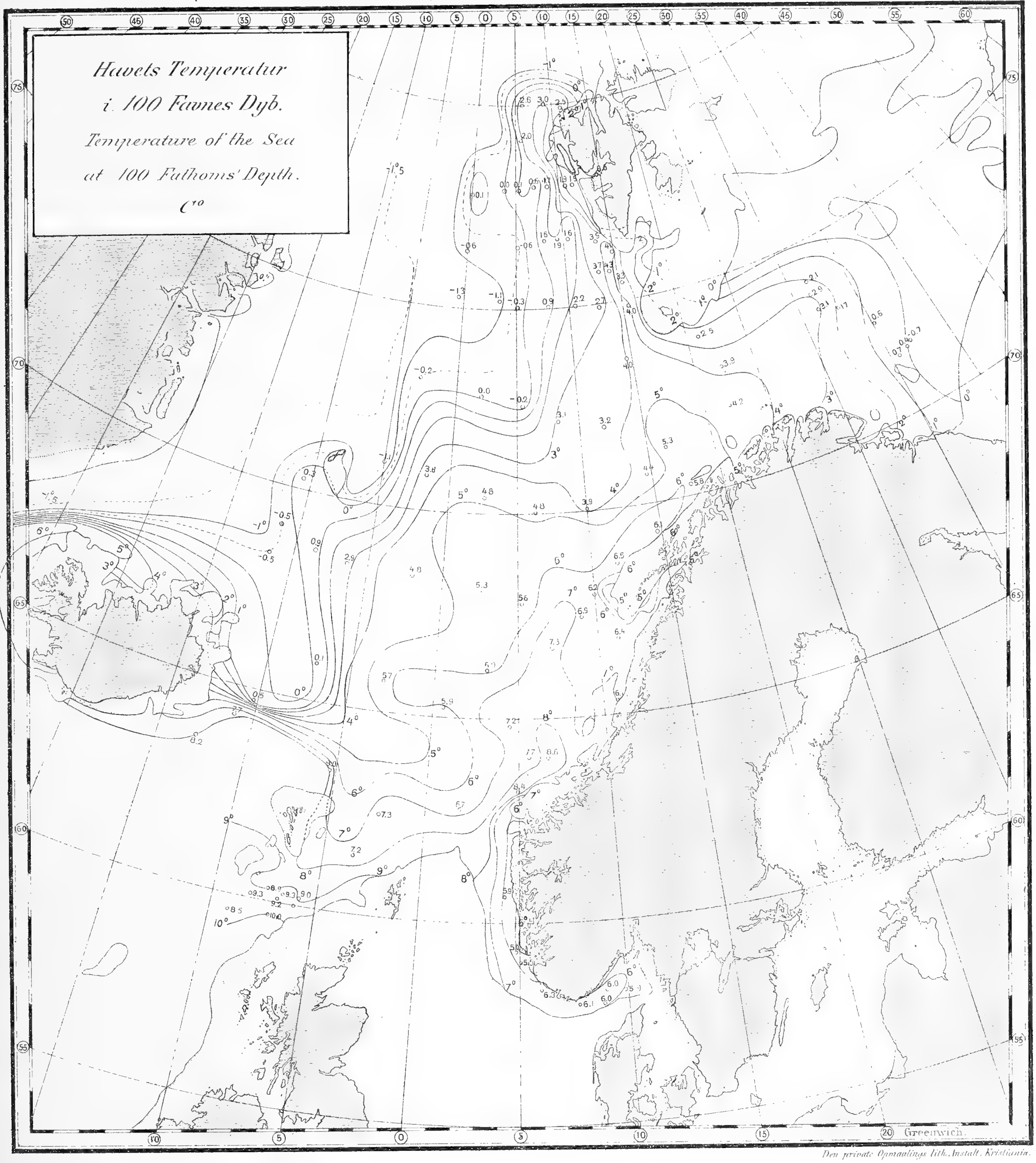


Den private Opmaalings lith. Anstalt. Kristiania.

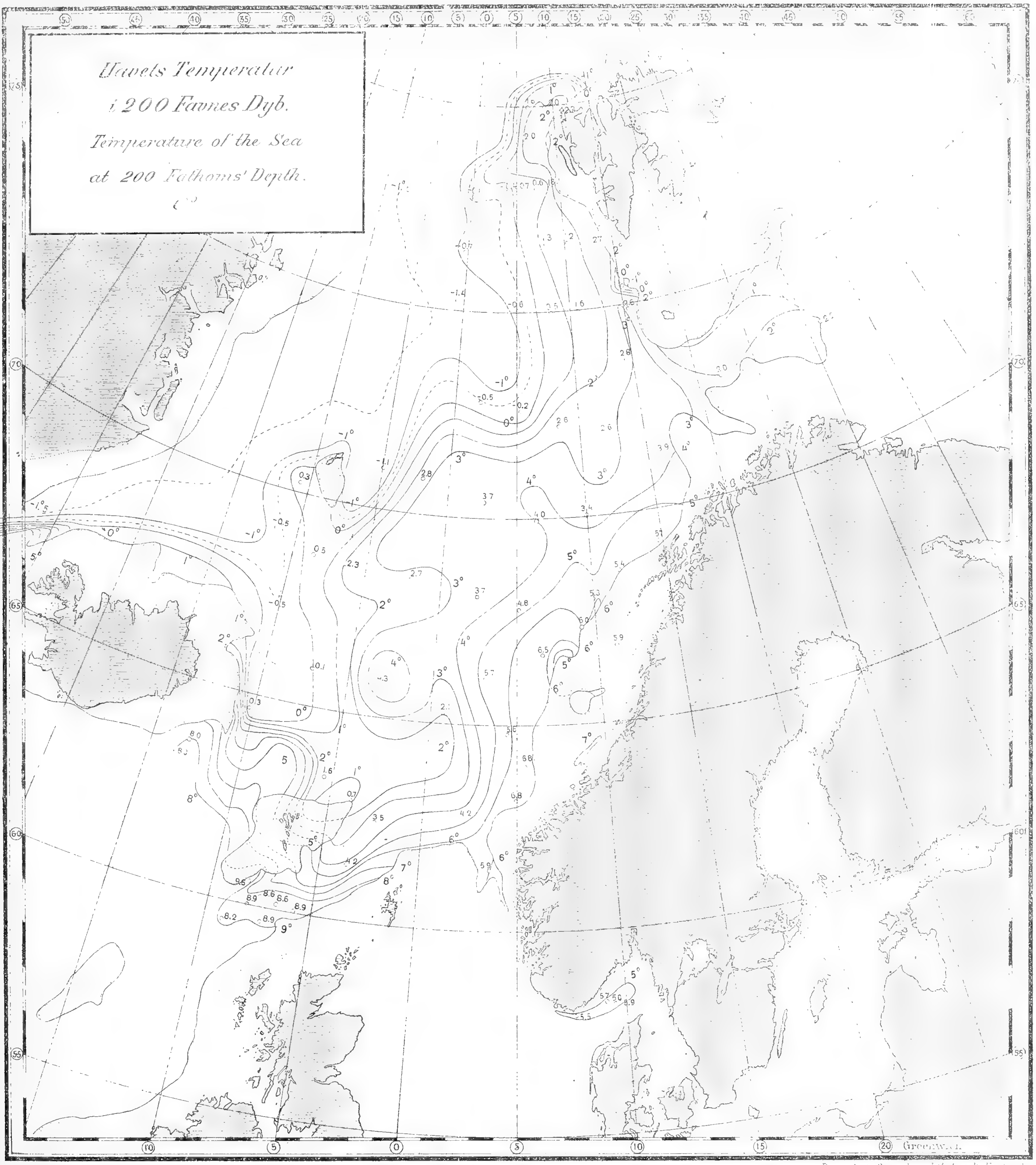


Den private Opmaalings lith. Anstalt Kristiania.

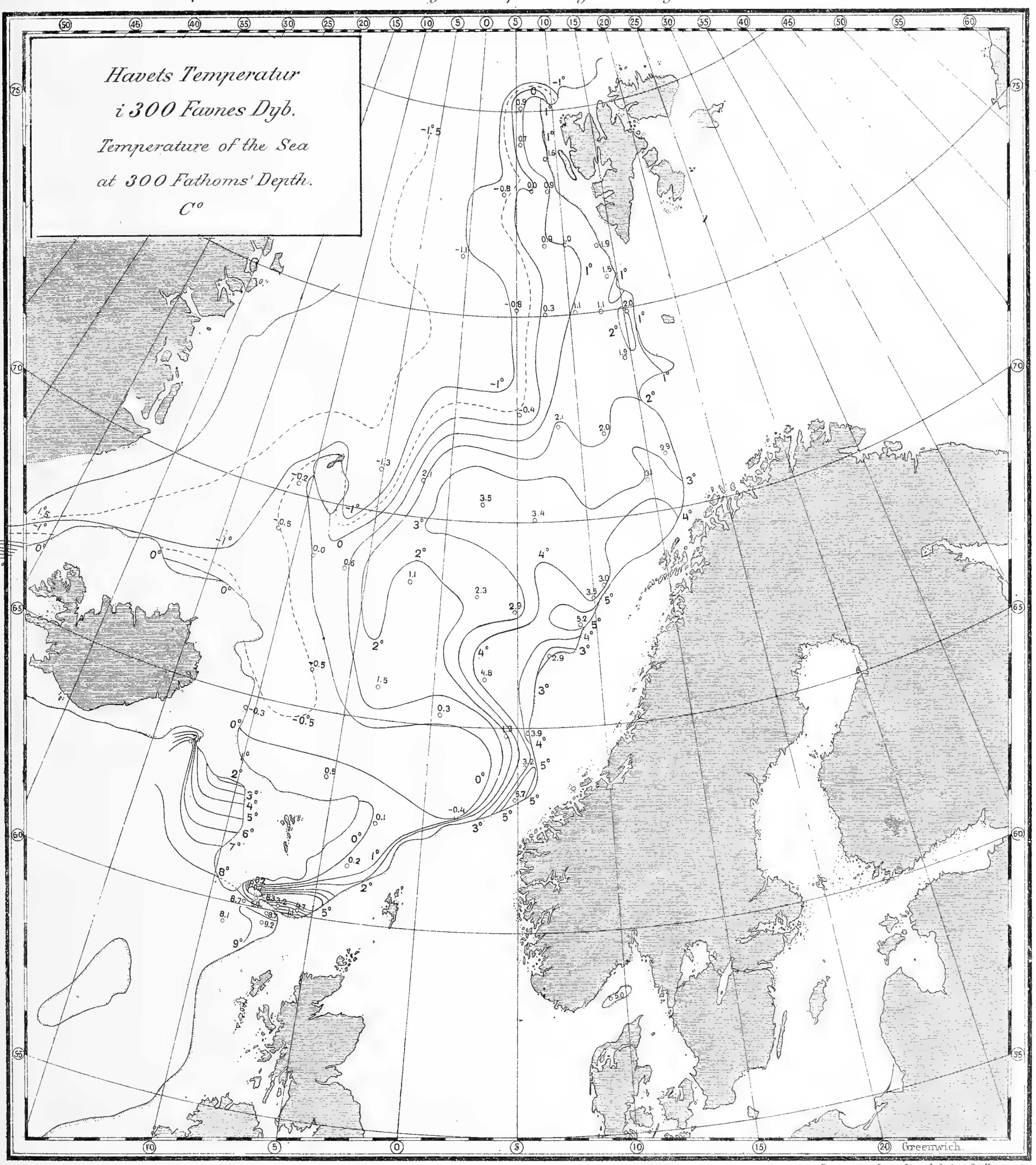

Hav-Overfladens Middeltemperatur
for Aaret:
Mean Temperature of the Sea Surface
for the Year.
C°



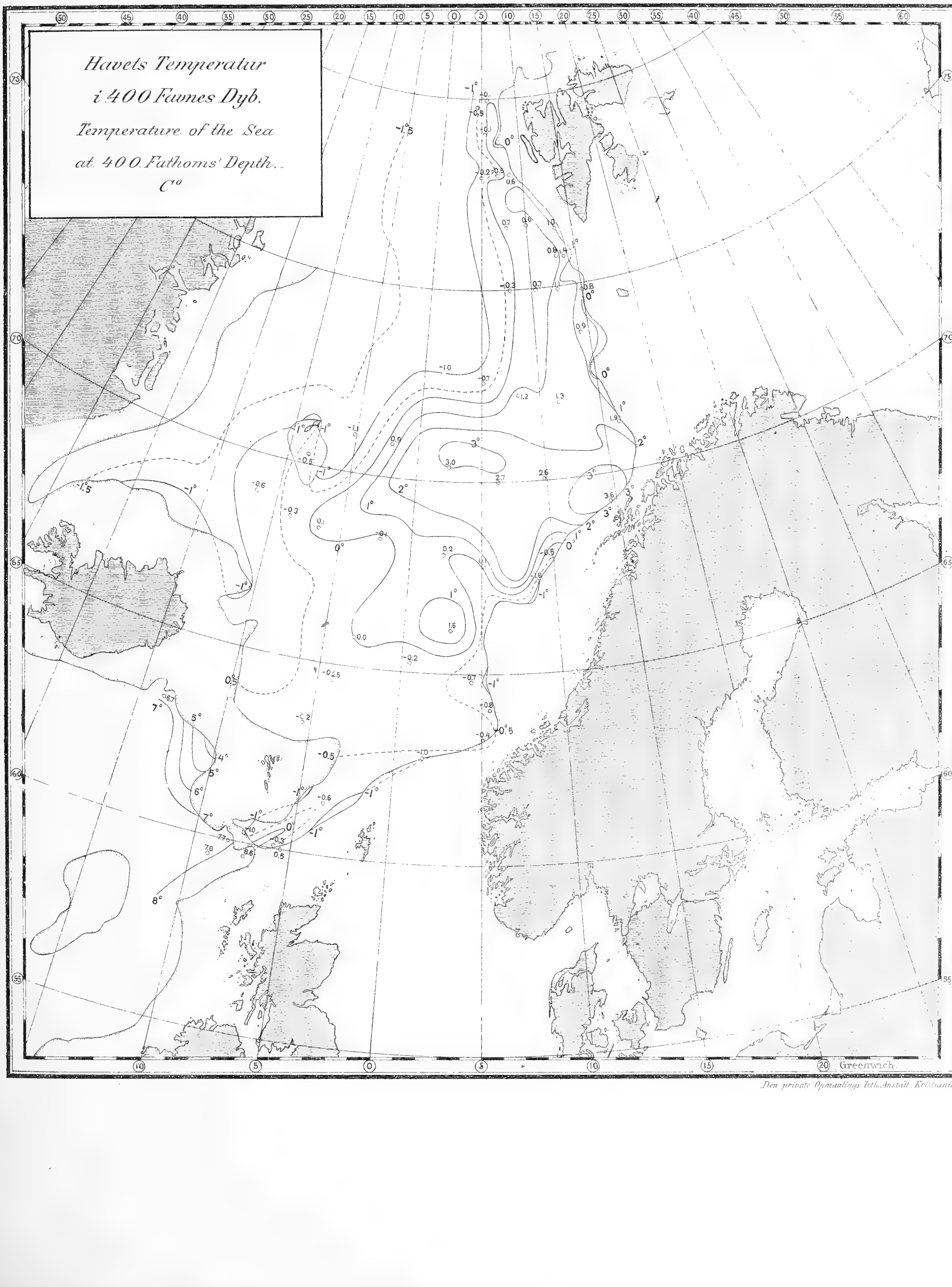
Den private Opmaalings lith. Anstalt. Kristiania.



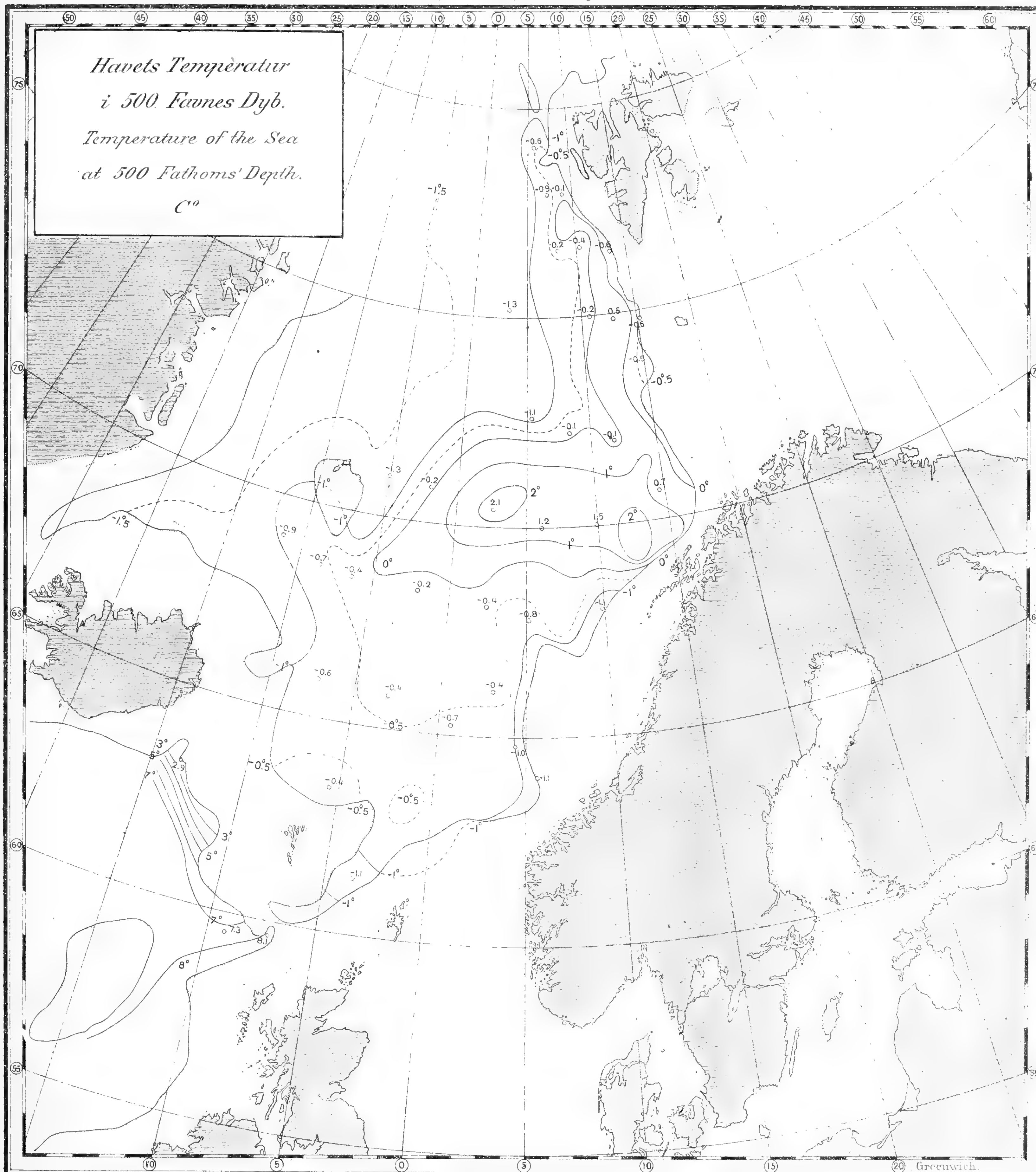
Den private Opmaalings lith. Anstalt. Kristiania



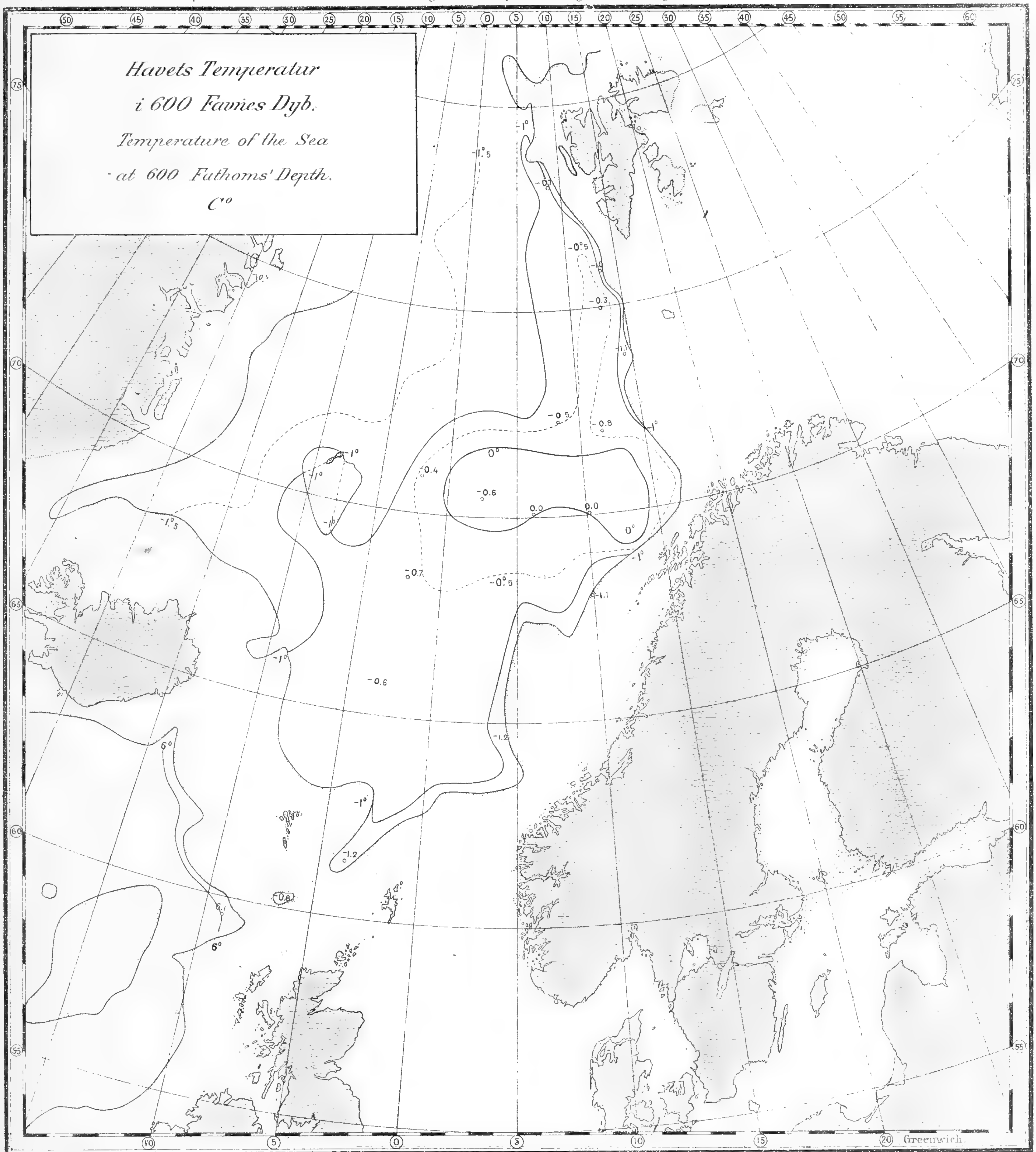
Den private Opmaalings lith. Anstalt. Kristiania.



Den private Opmaalings lith. Anstalt. Kristiania



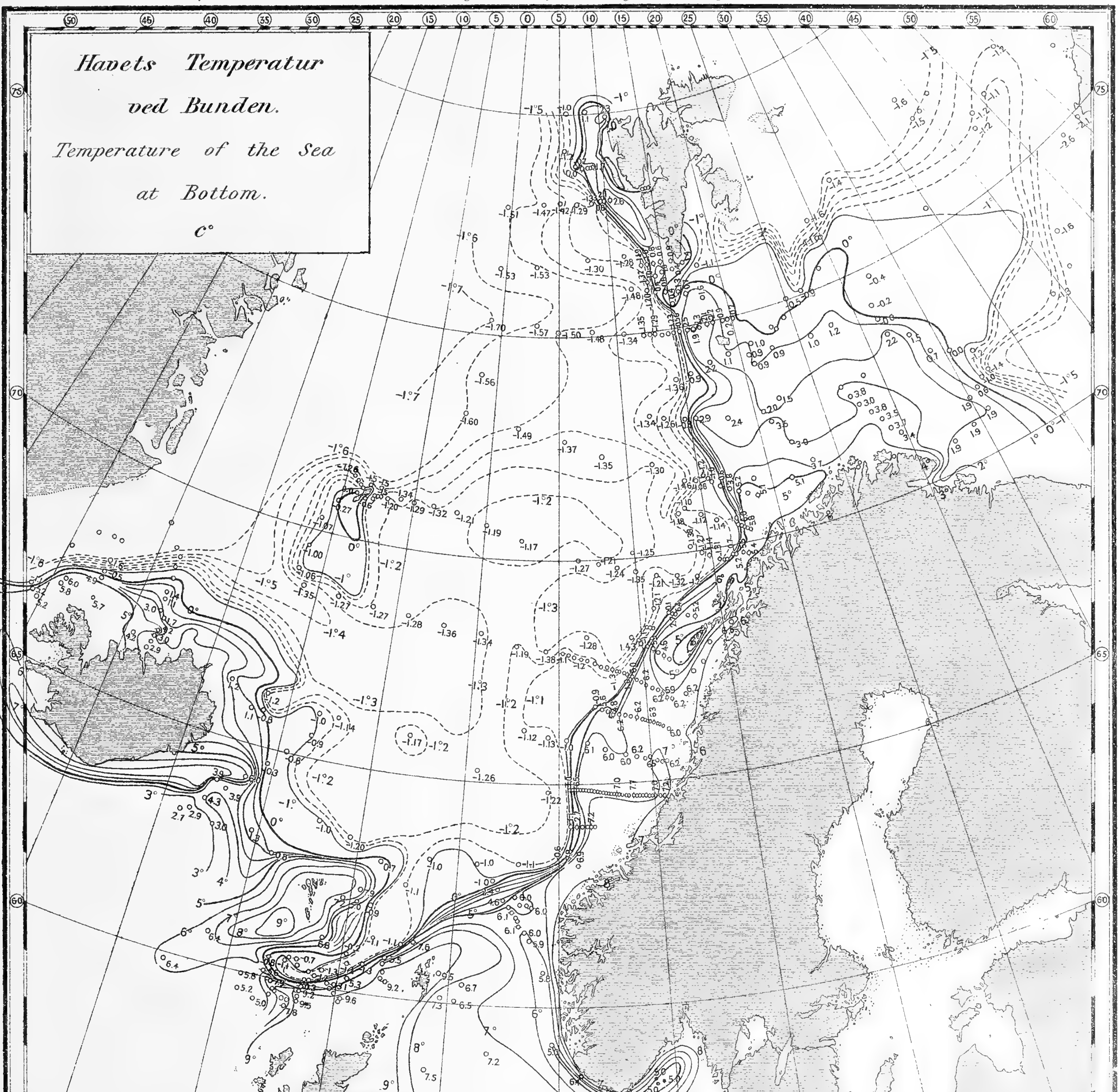
Den private Opmaalings lith. Anstalt. Kristiania.



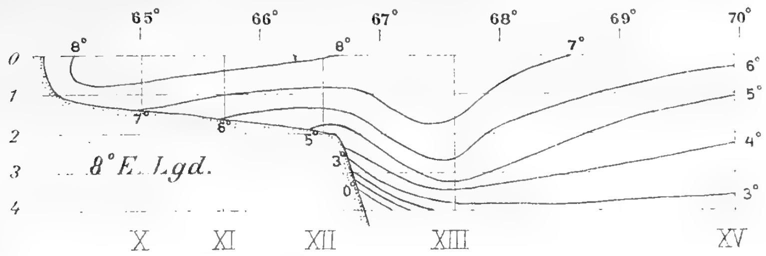
Den private Opmaalings lith. Anstalt. Kristiania.

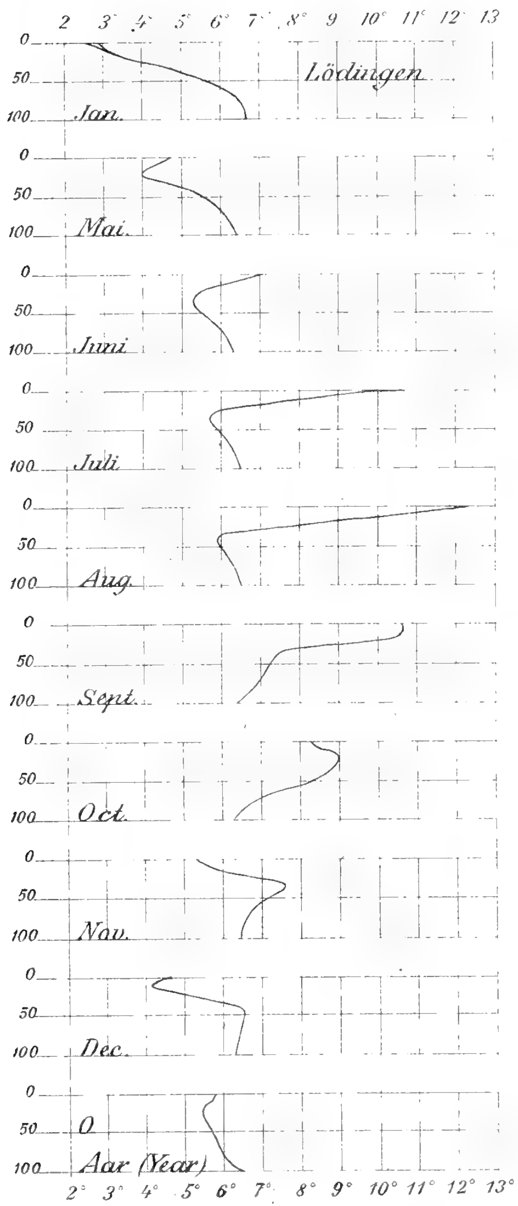
Den private Opmaalings lith. Anstalt. Kristiania.

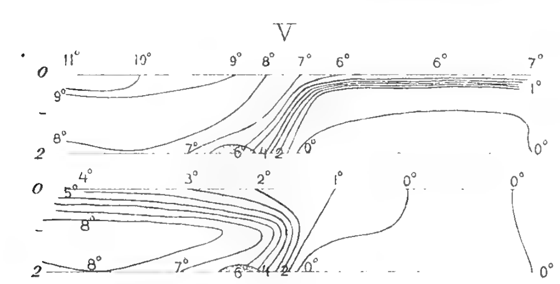

Havets Temperatur
i 1500 Favnes Dyb.
Temperature of the Sea
at 1500 Fathoms' Depth.
C°

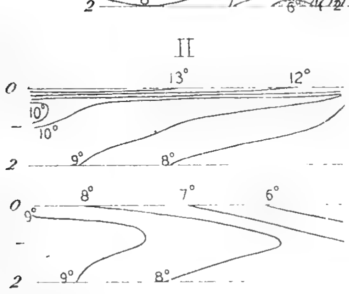


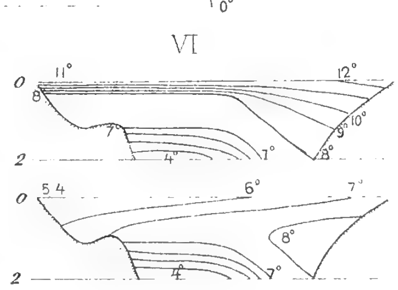
Den private Opmaalings lith. Anstalt. Kristiania.

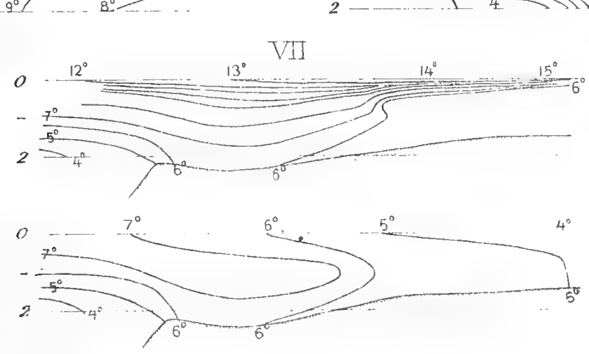


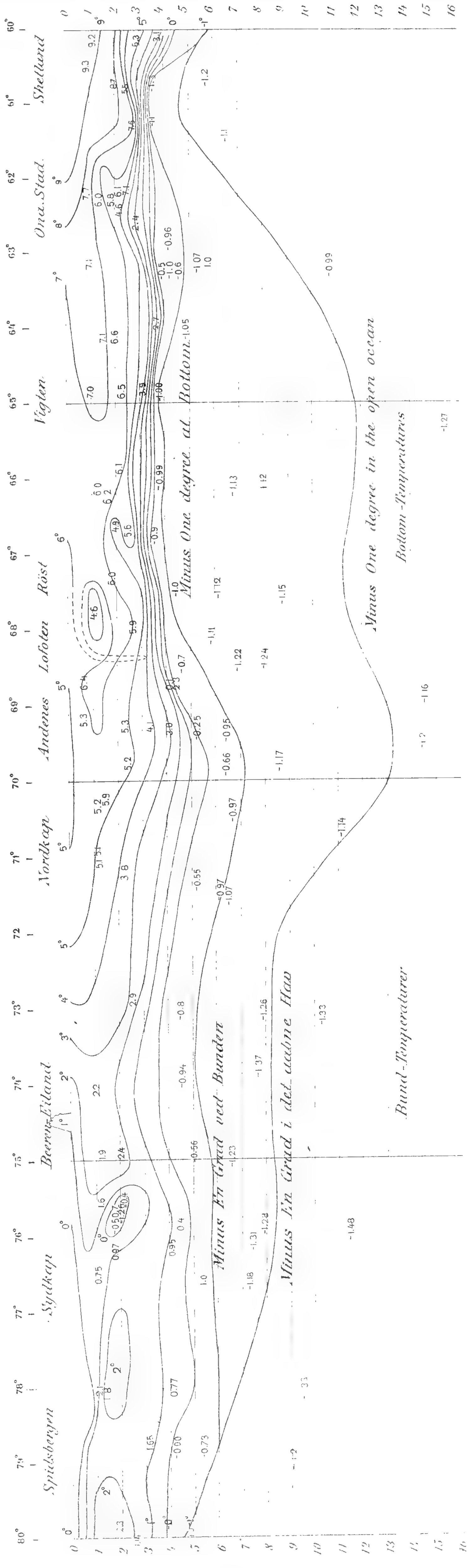




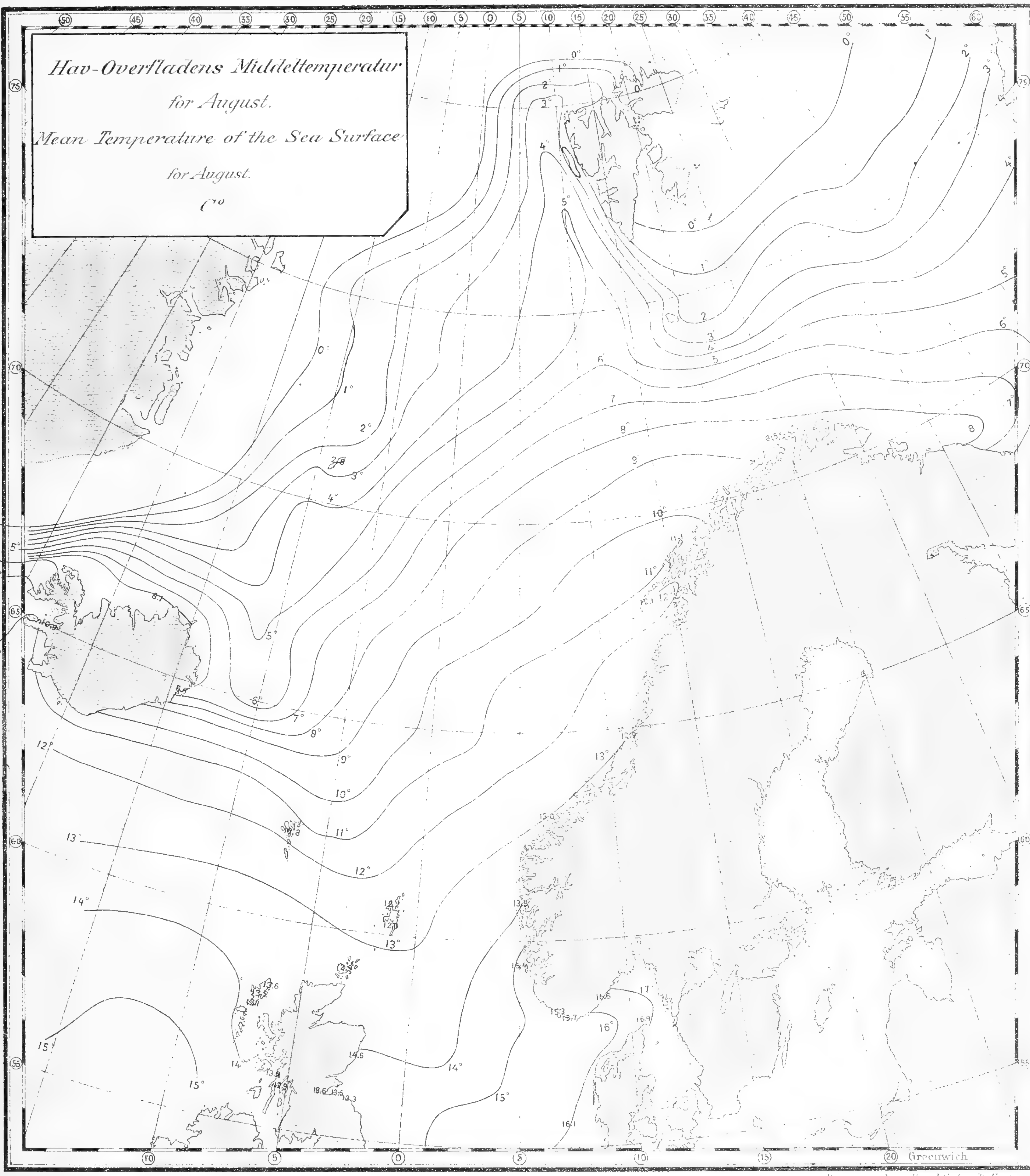


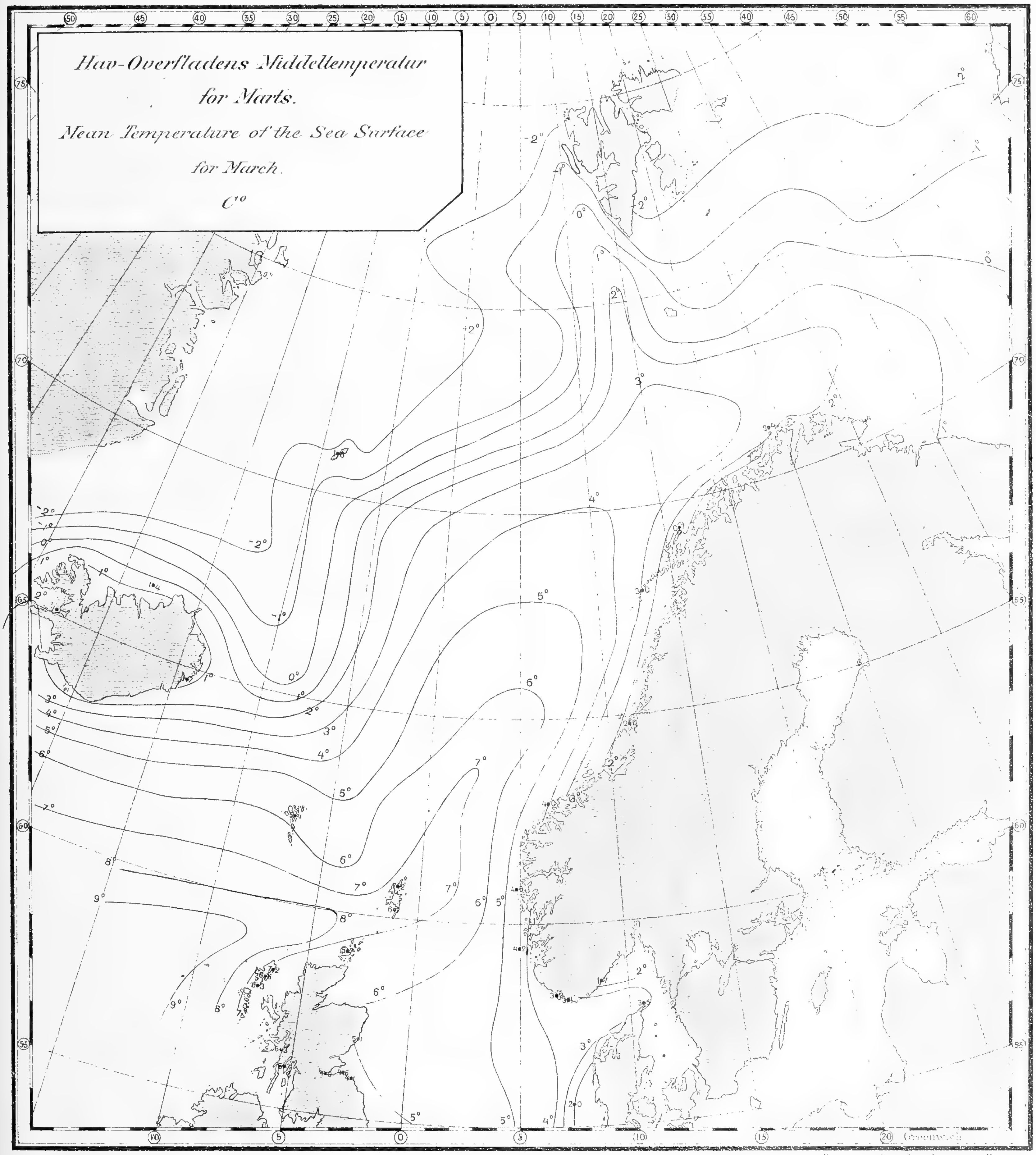


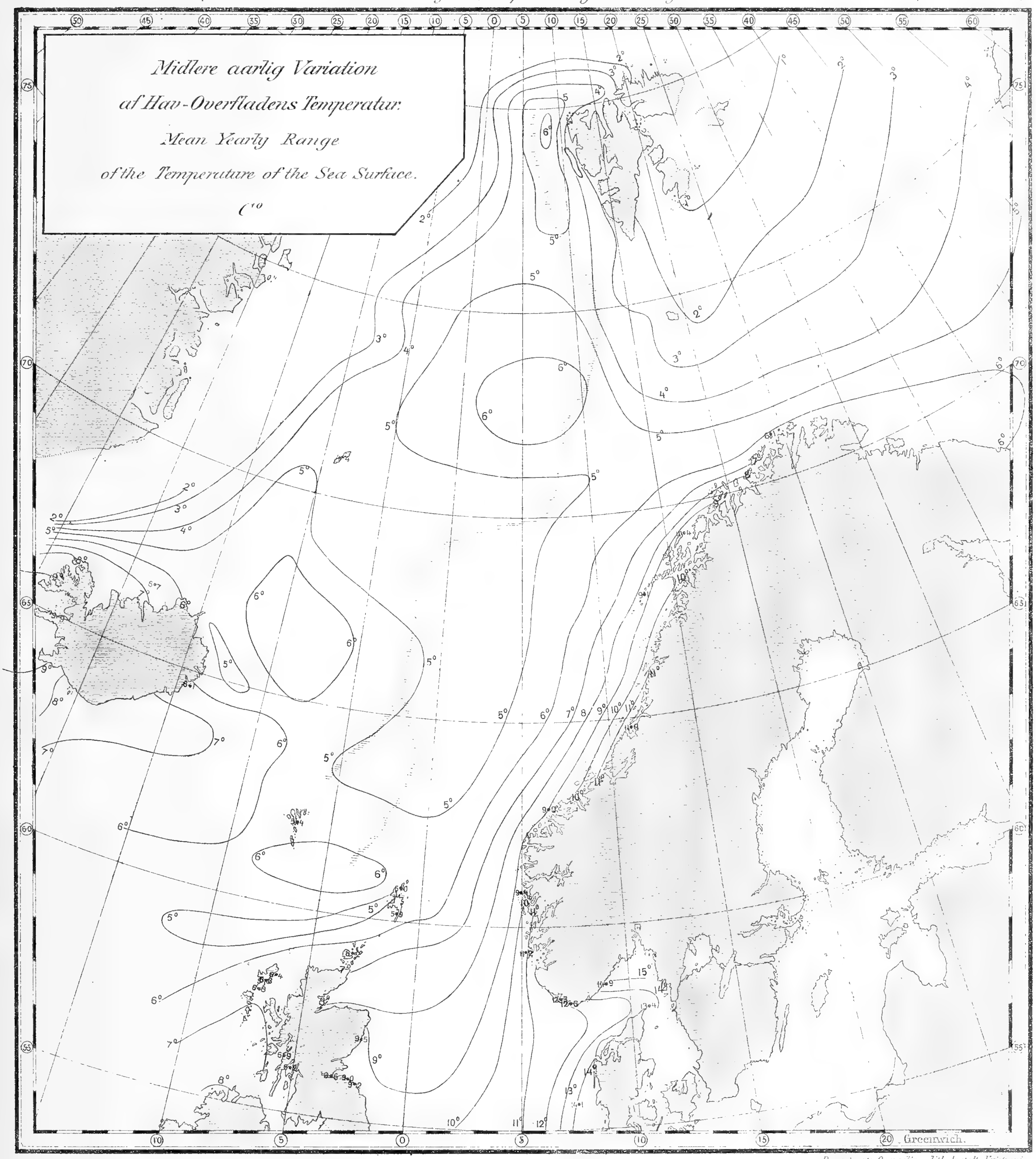




Det private Opmaalings lith. Anstalt, Kristiania.

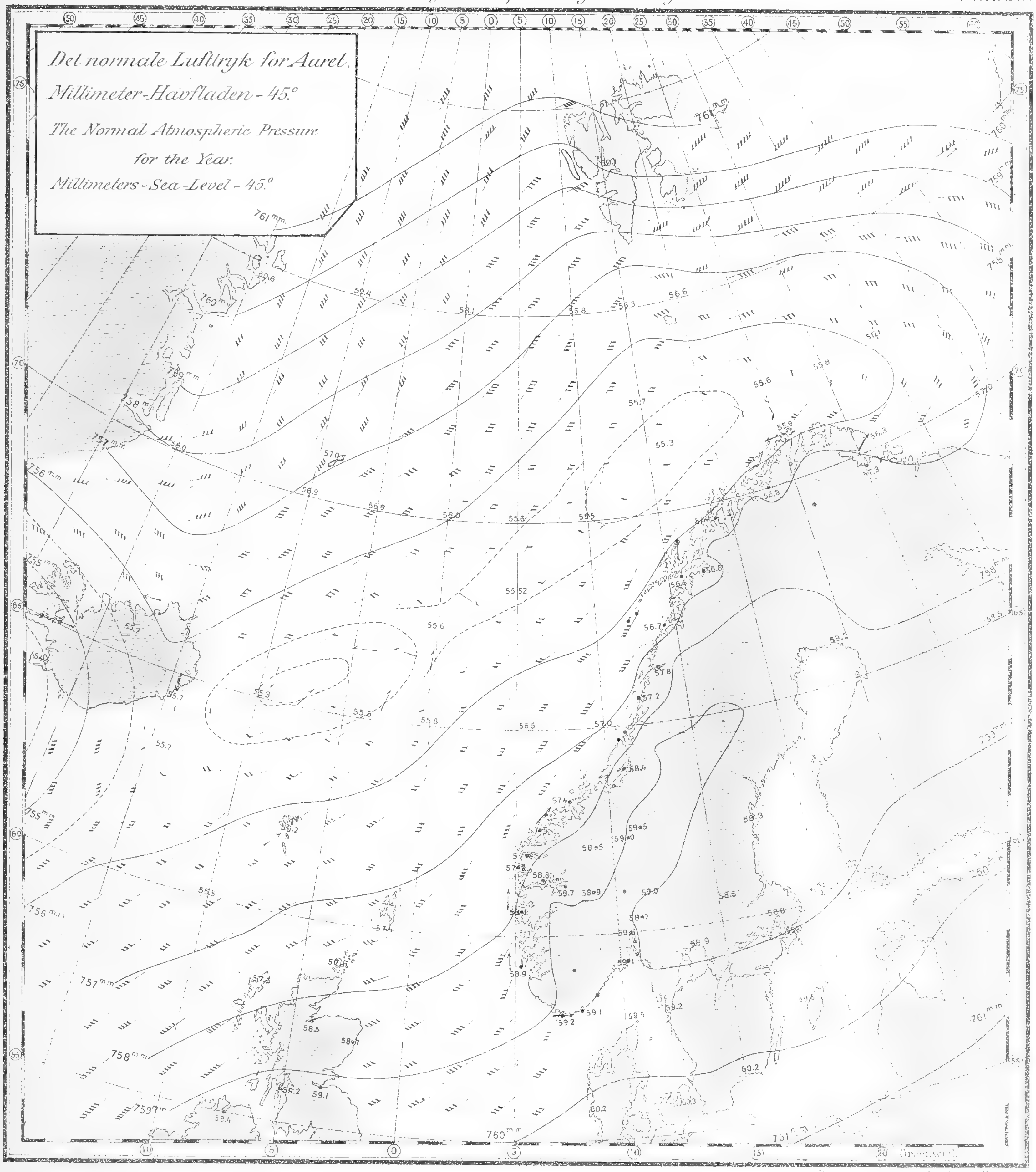

Hav-Overfladens Middeltemperatur
for August.
Mean Temperature of the Sea Surface
for August.
C°
Greenwich


Hav-Overfladens Middeltemperatur
for Marts.
Mean Temperature of the Sea Surface
for March.
C°
Greenwich

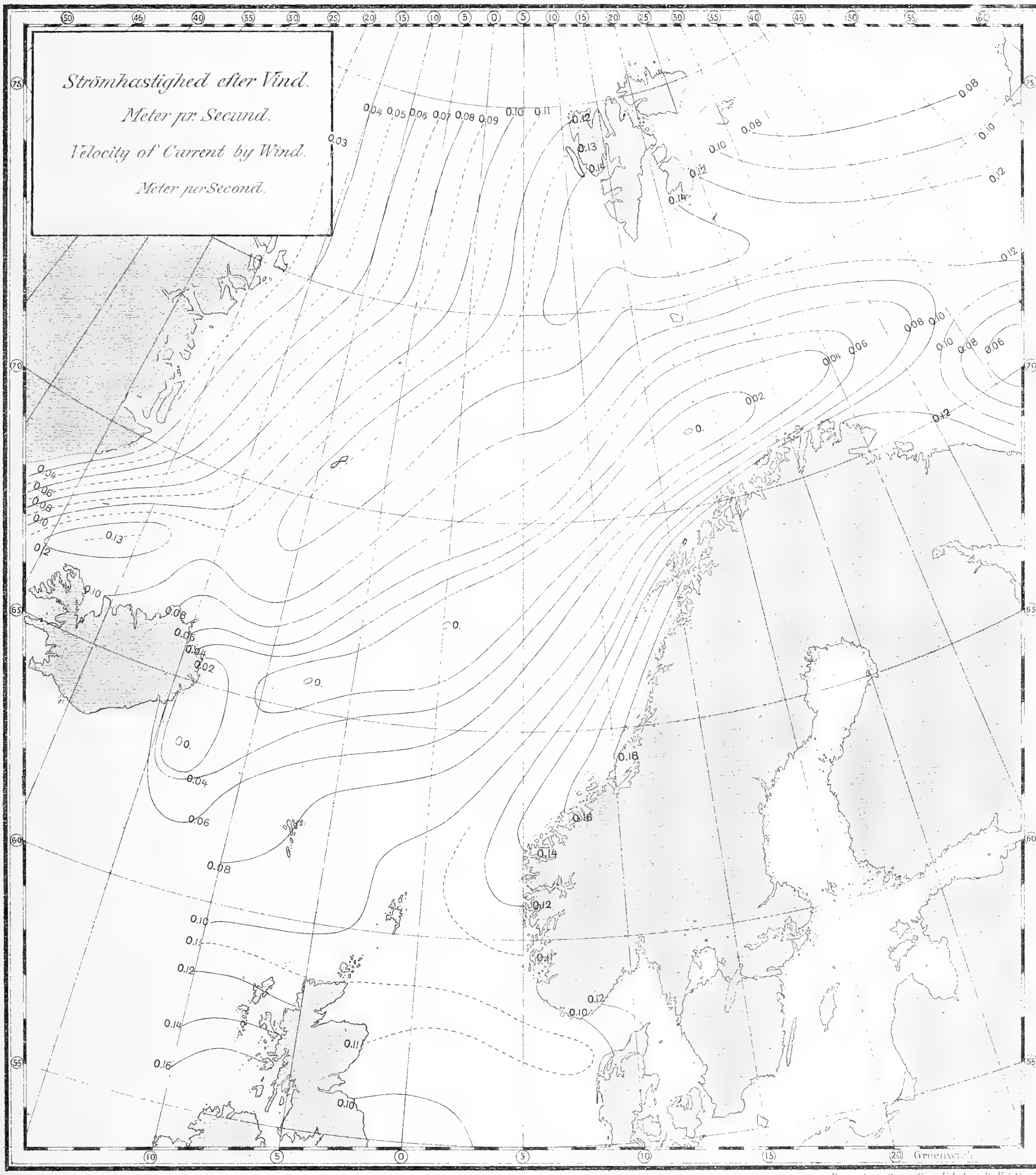


Den private Opmaalings Lith. Anstalt Kristiania.

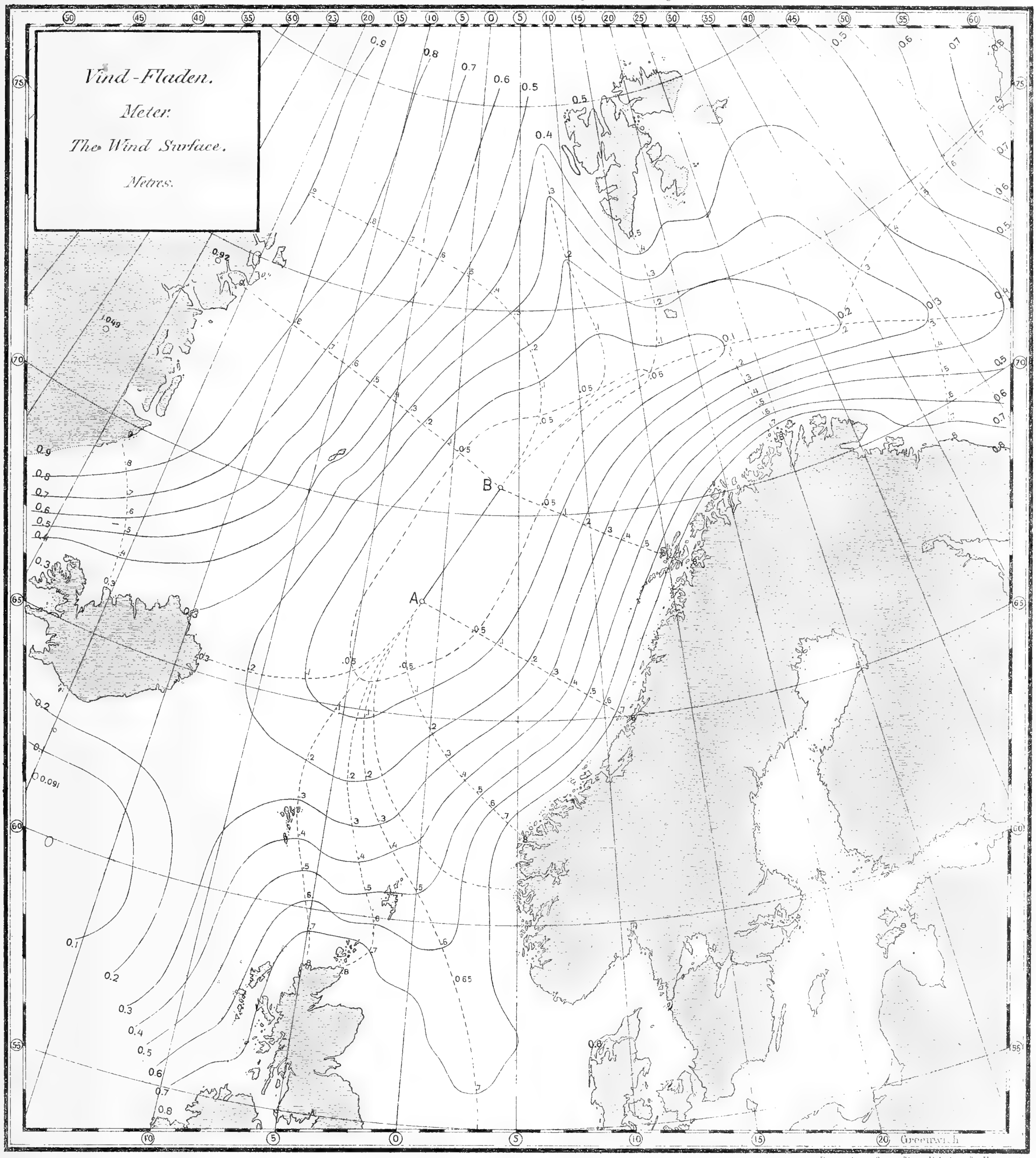

XXV
XXIV
XXIII
XXII
XXVI
XIX
XXVII
XVII
XV
XIII
X
VII



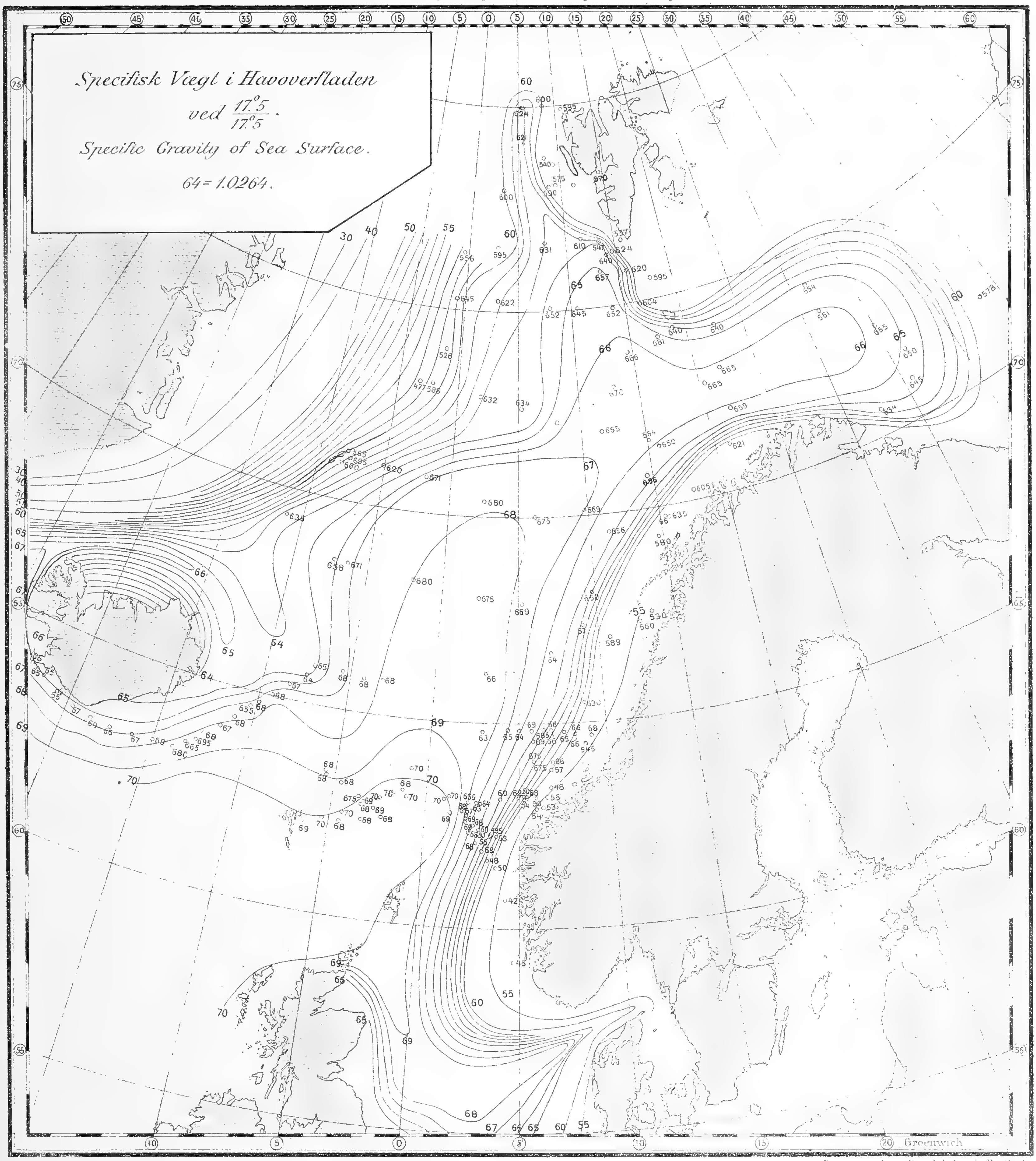
Det private lith. Institut Kristiania



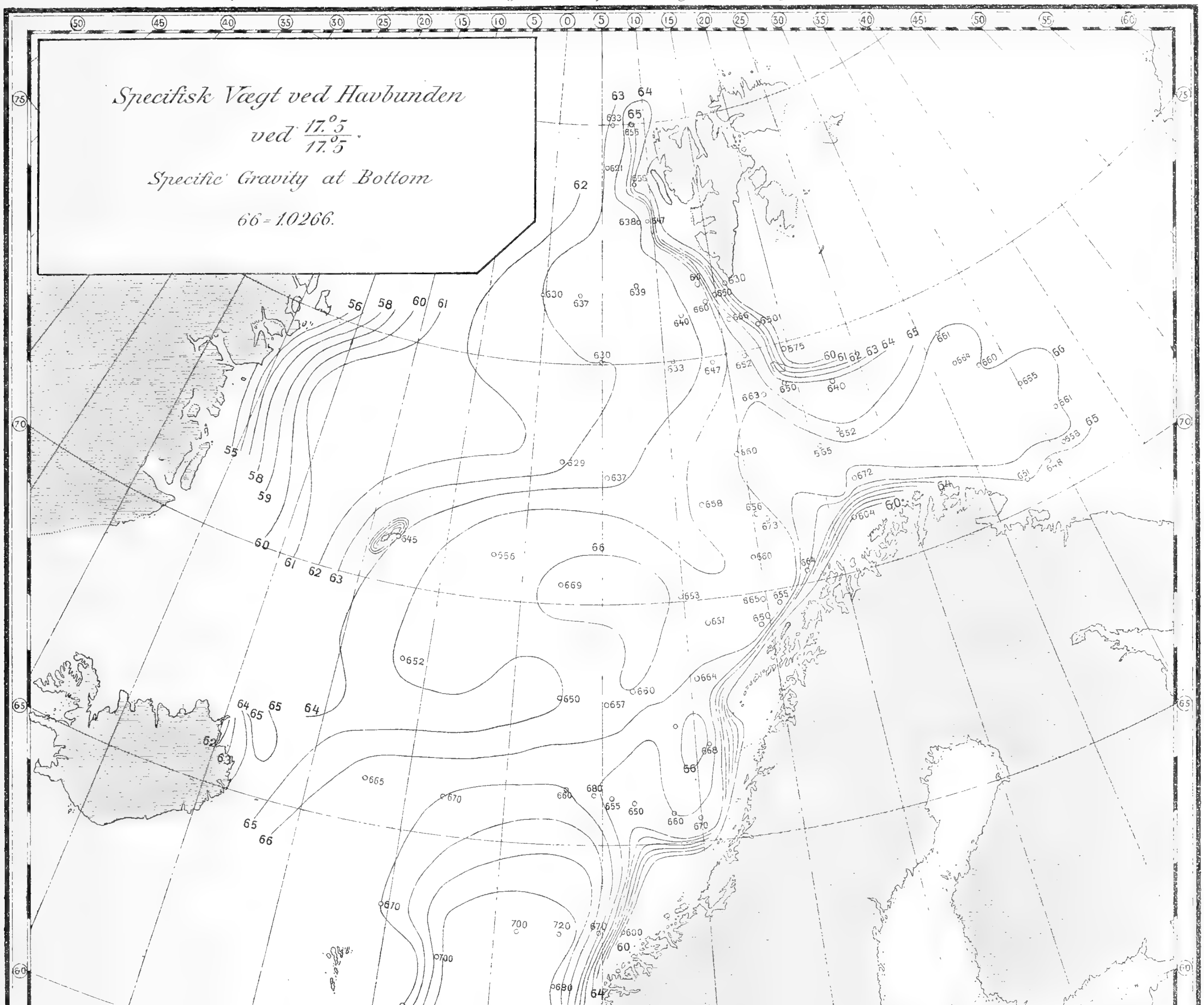
Den private Opmaalings lith. Anstalt. Kristiania.



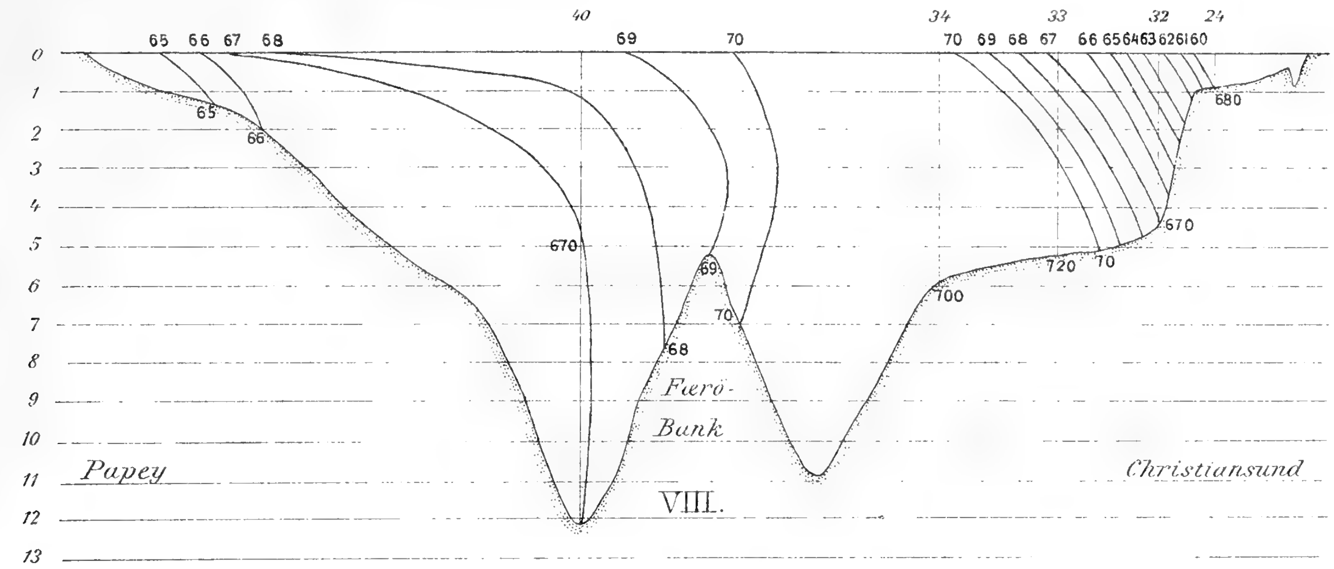
Den private Opmaalings lith. Anstalt, Kristiania.

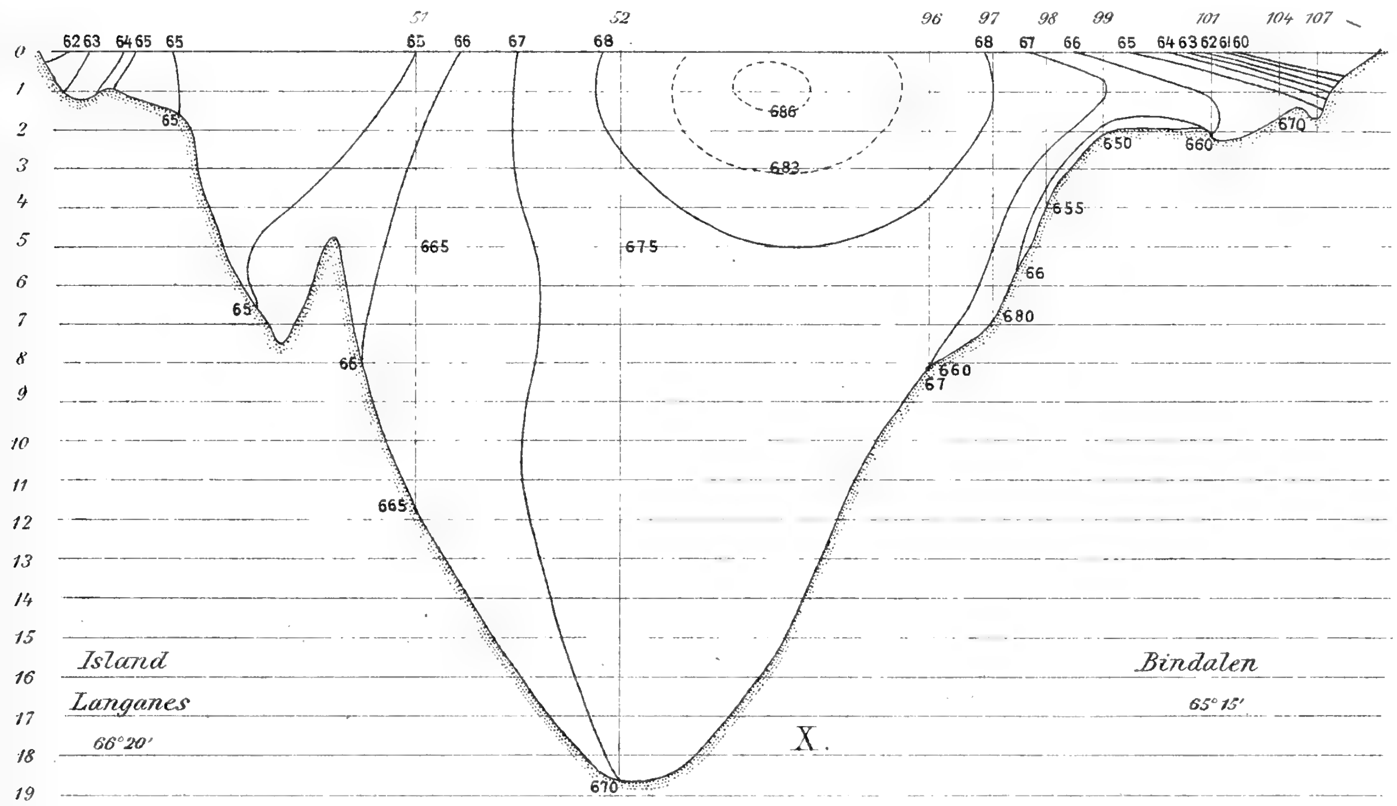


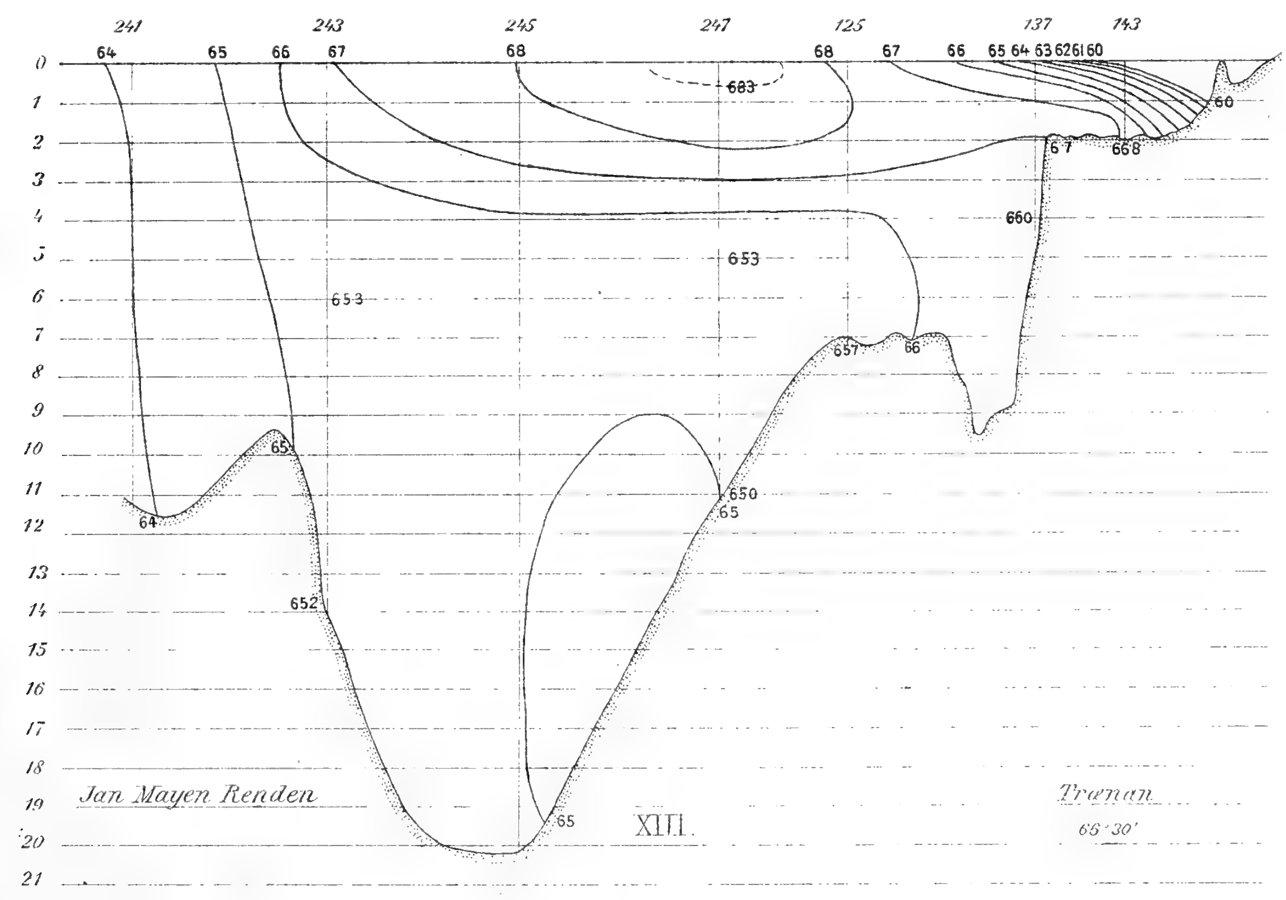
Den private Opmaalings lith. Anstalt, Kristiania.



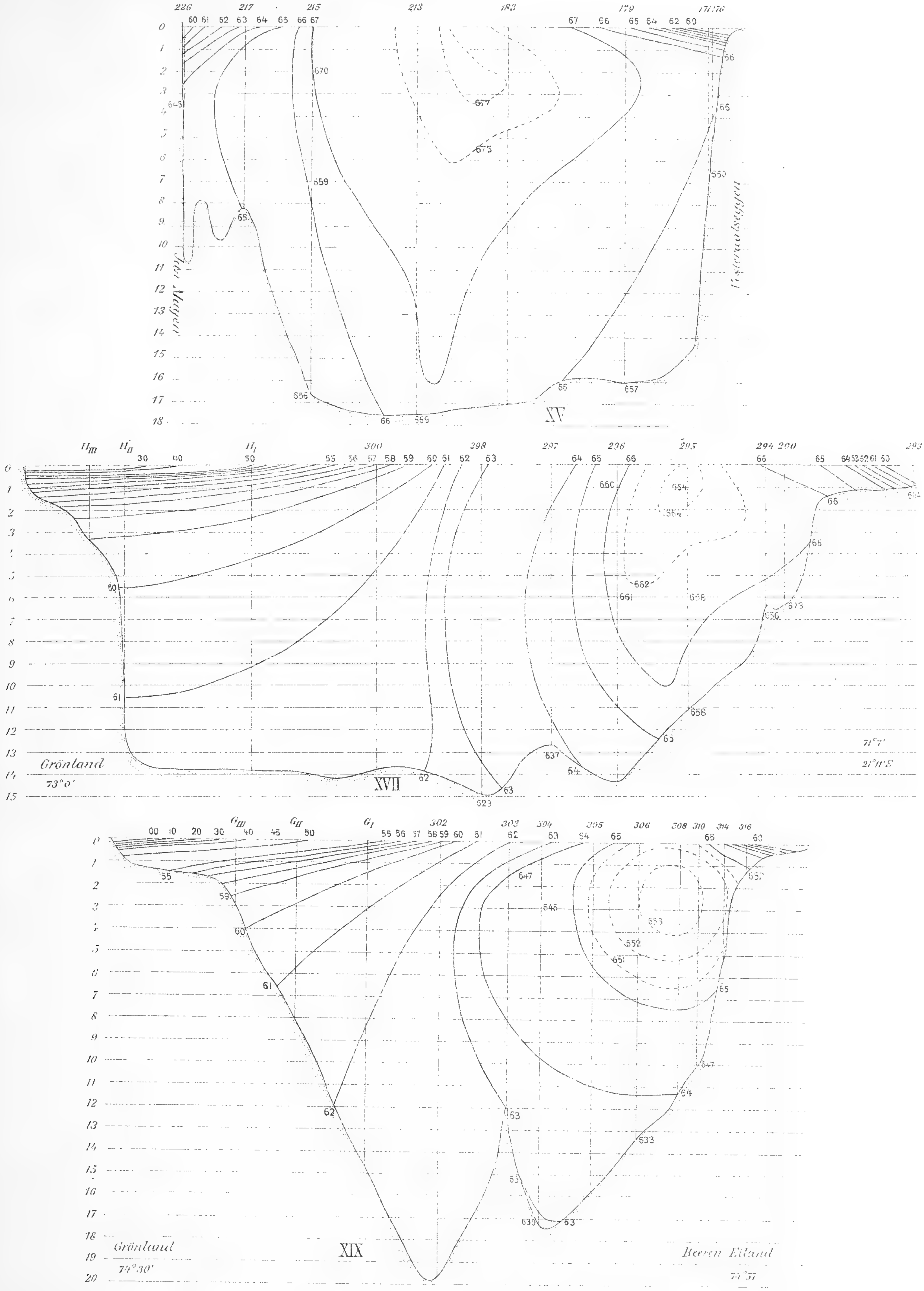
Den private Opmaalings lith. Anstalt, Kristiania.



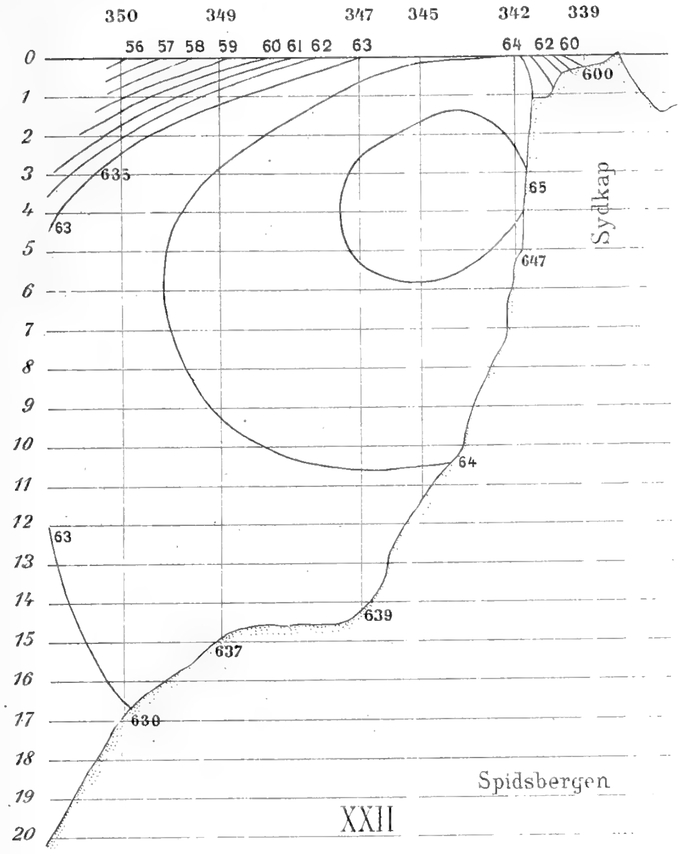


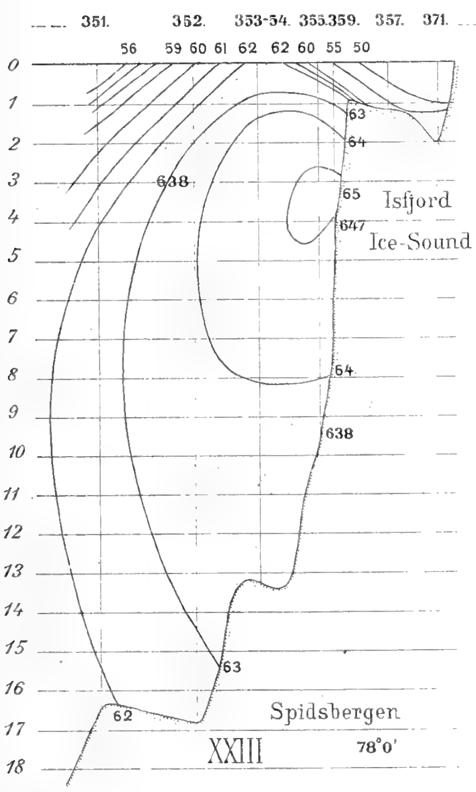


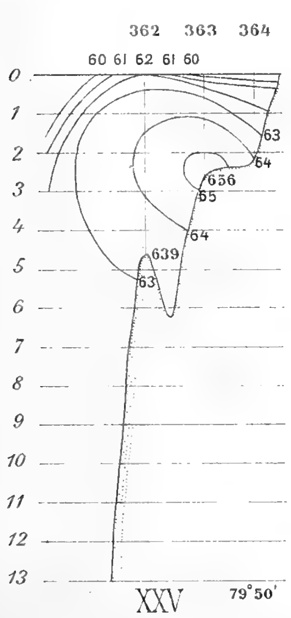
Den private Opmaalings lith. Anstalt. Kristiania.

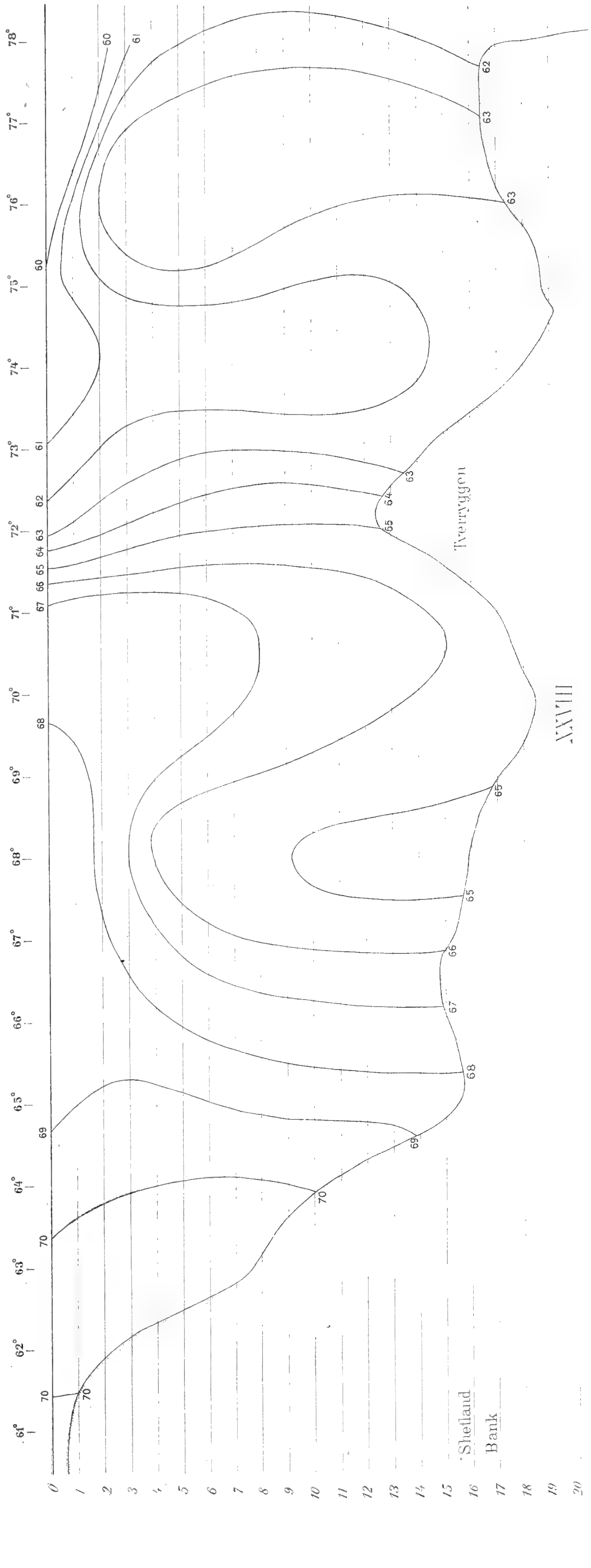


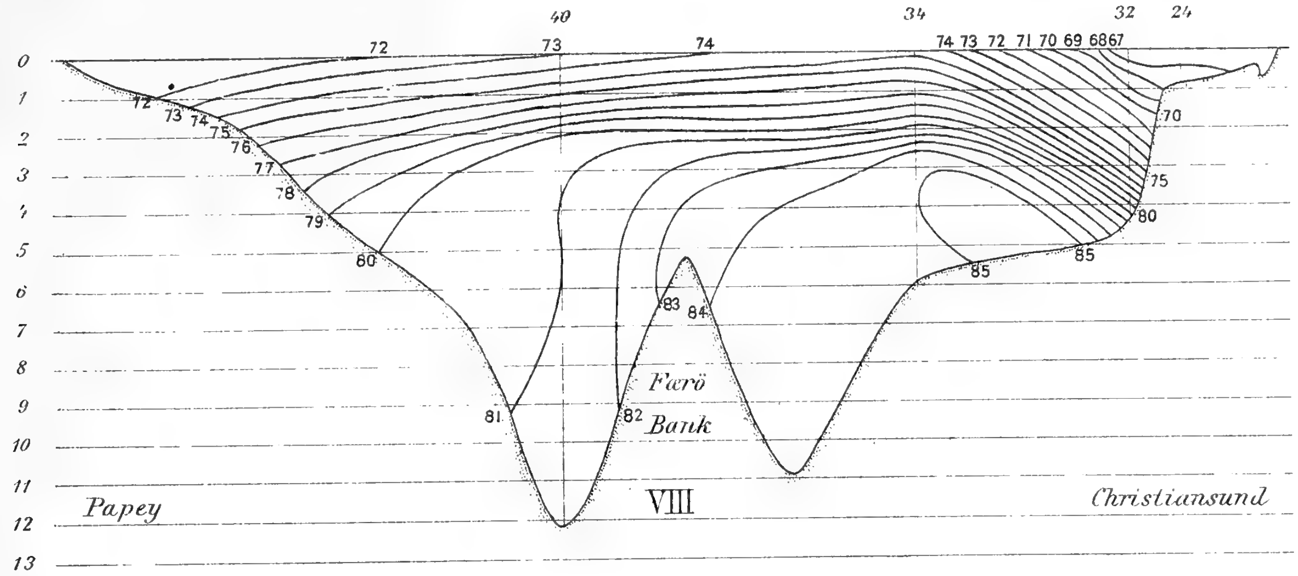
Den private Opmaalings lith. Anstalt, Kristiania

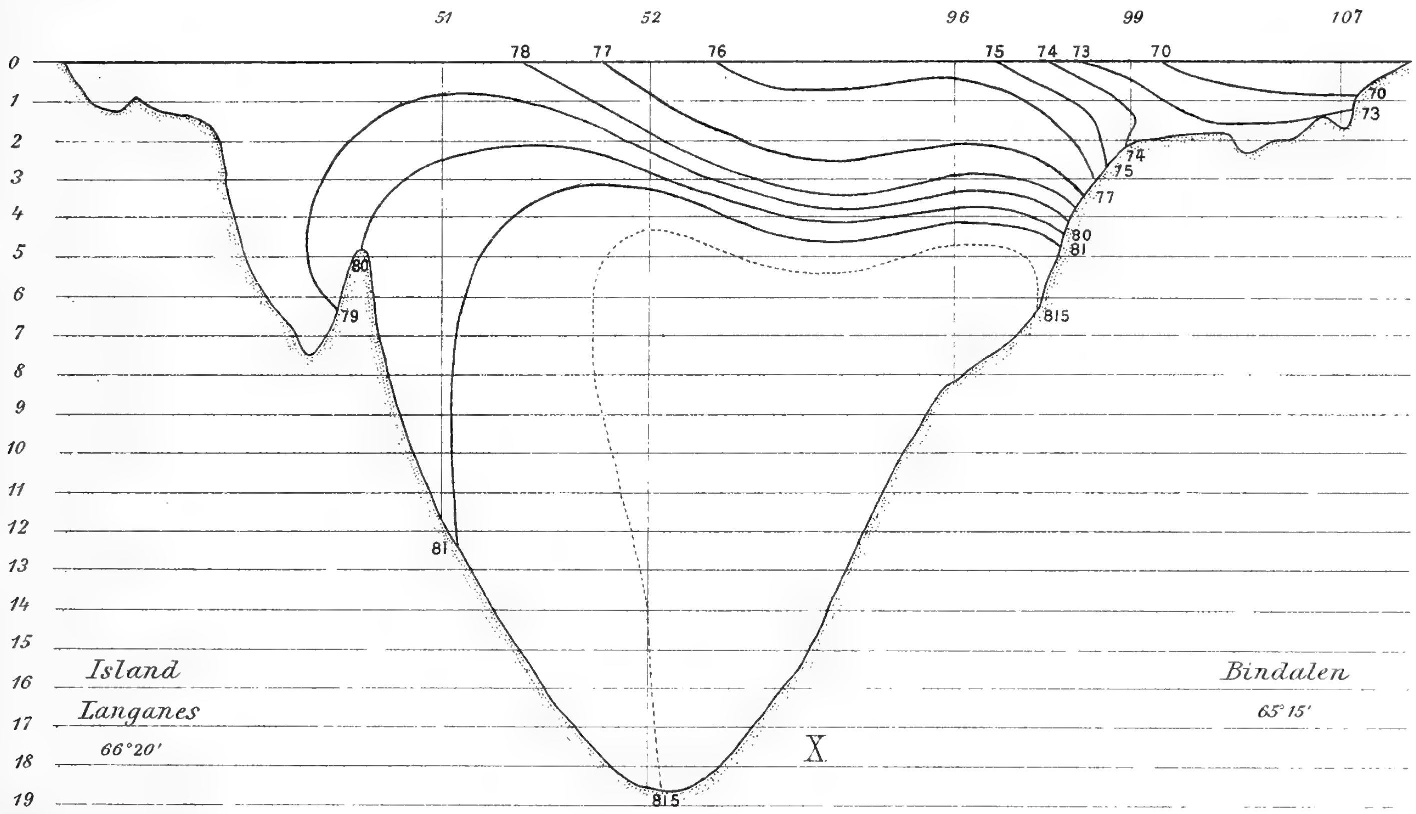

Sydkap
Spidsbergen
XXII

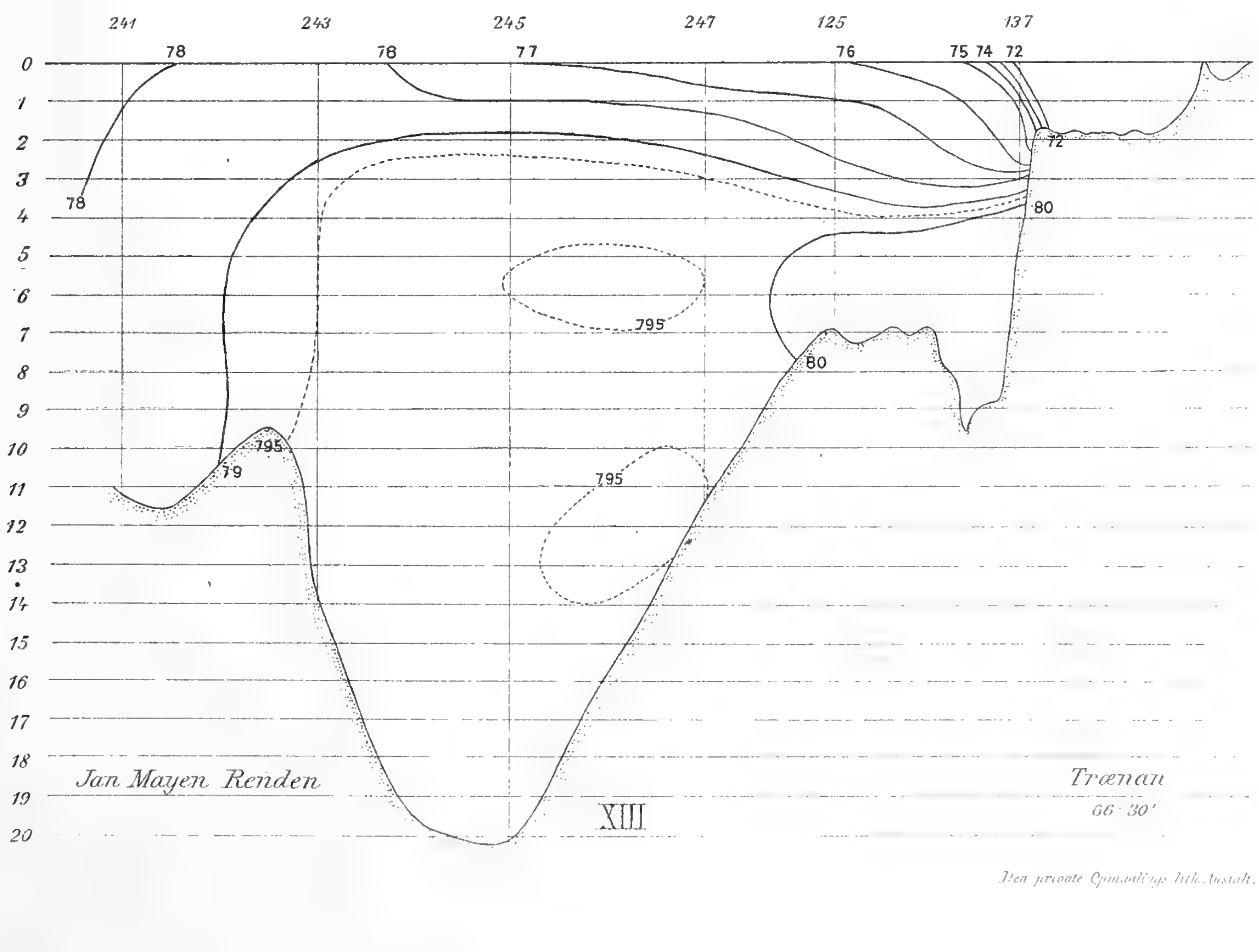

Isfjord
Ice-Sound
Spidsbergen
XXIII
78°0'


XXV
79°50'

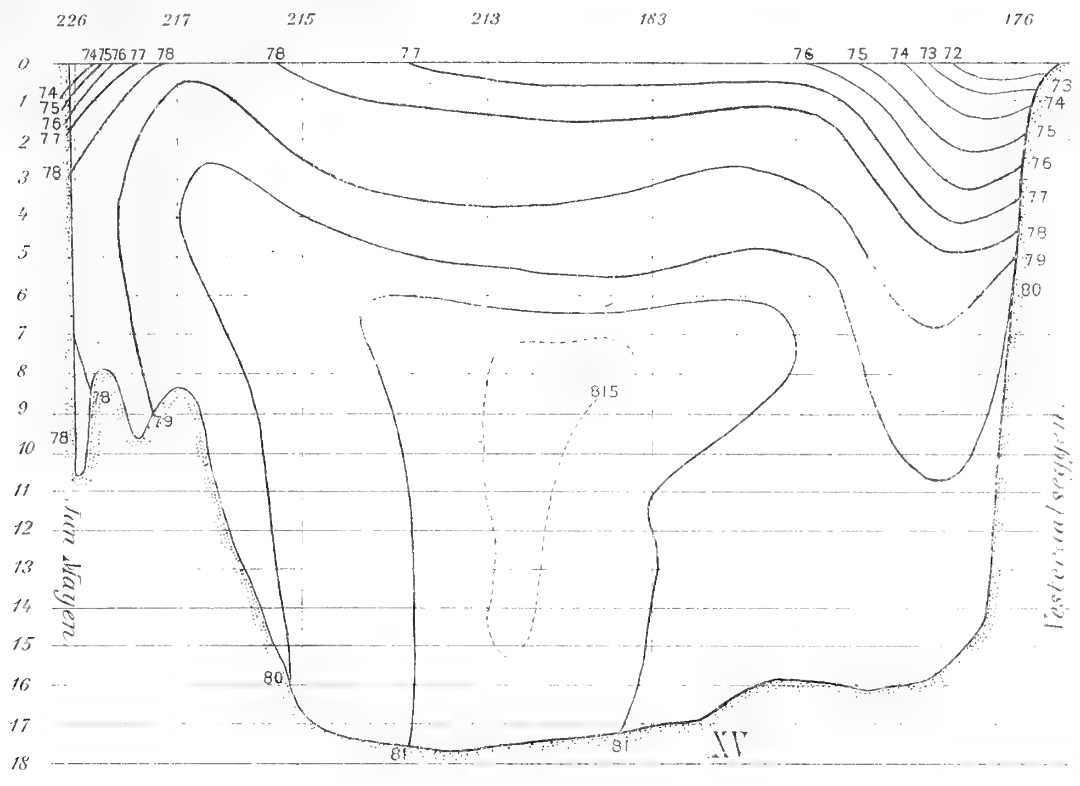

Tverryggen
XXVIII
Shetland
Bank

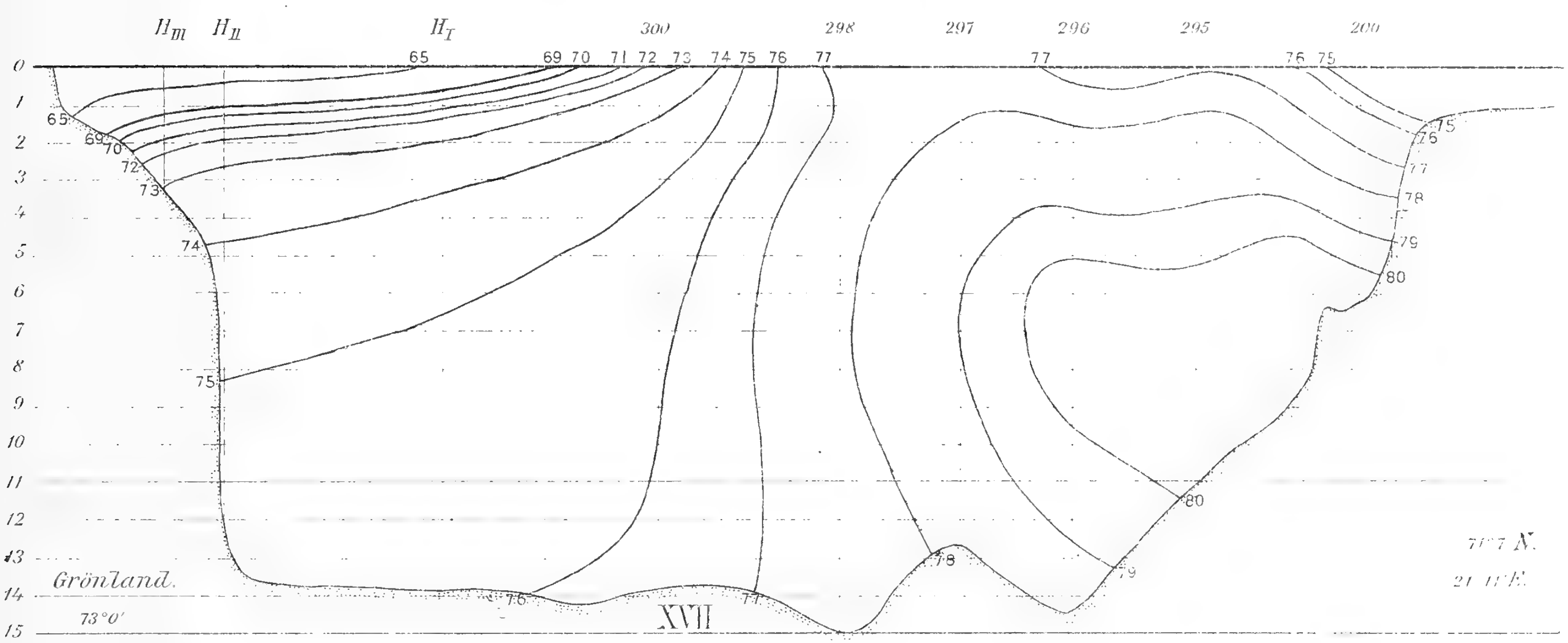


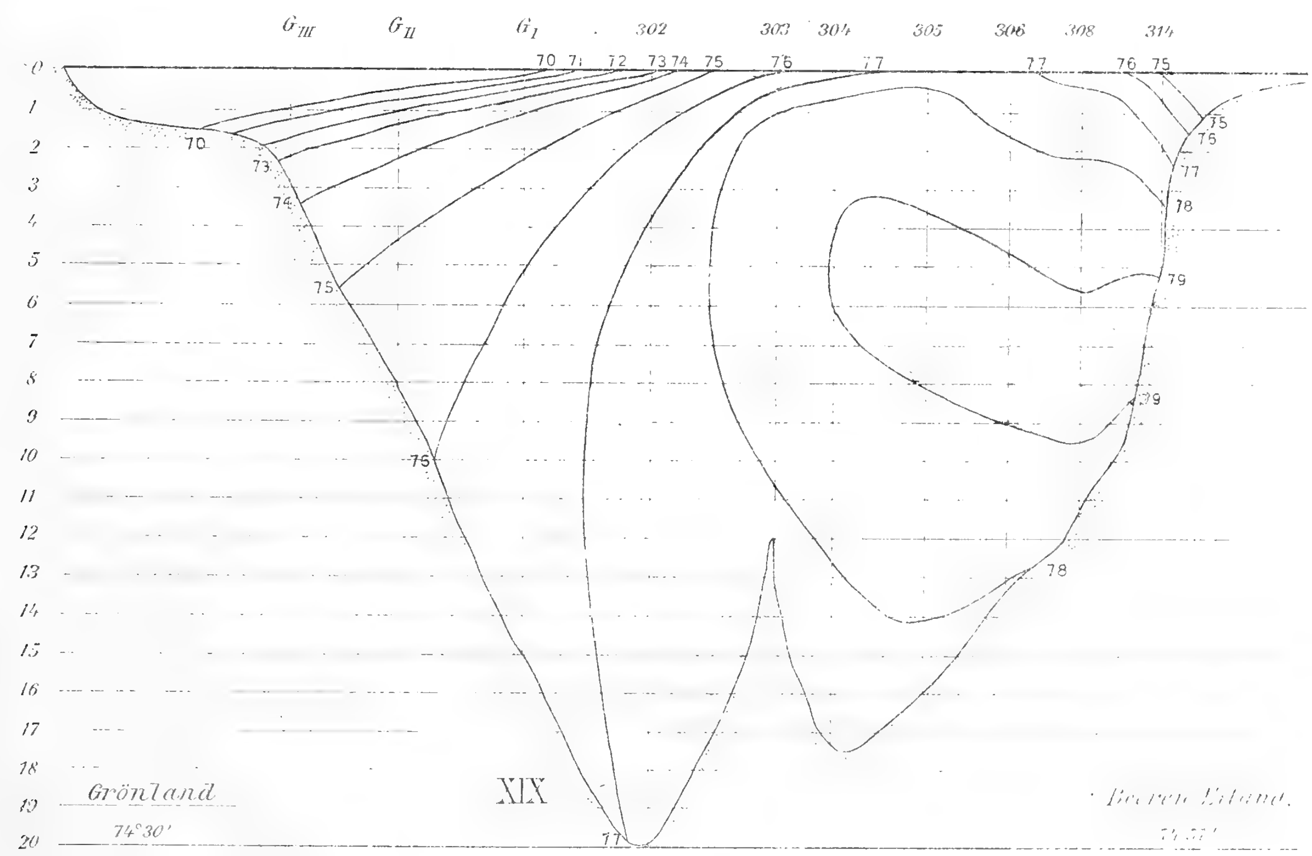


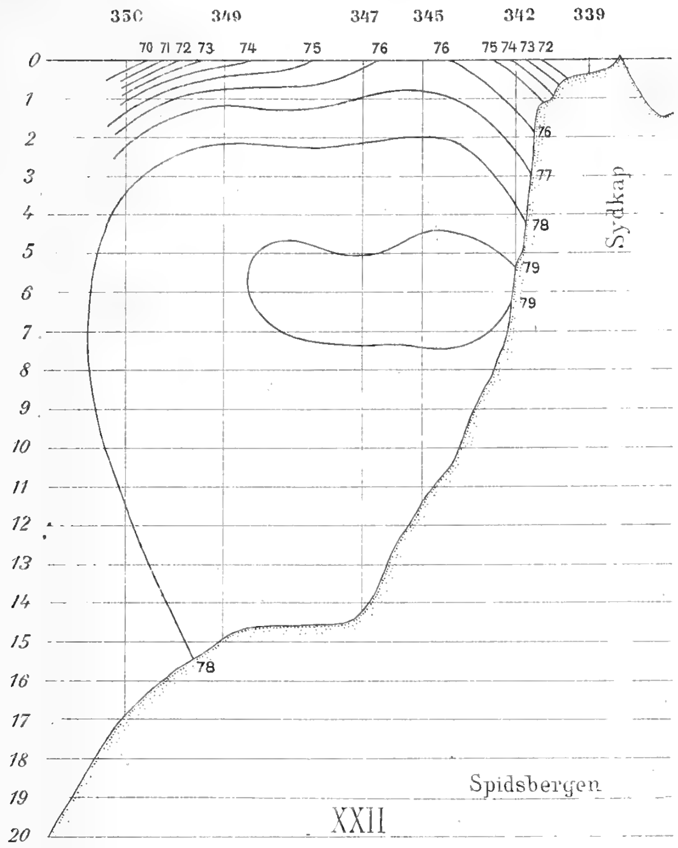


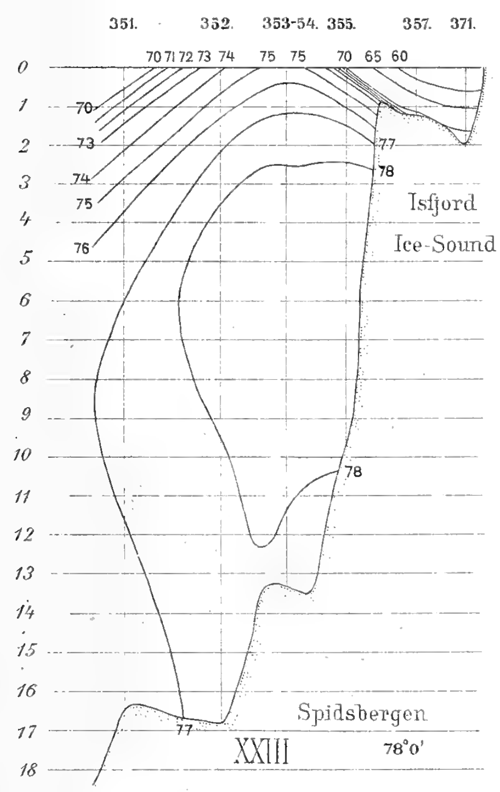
Den private Opmaalings lith. Anstalt. Kristiania

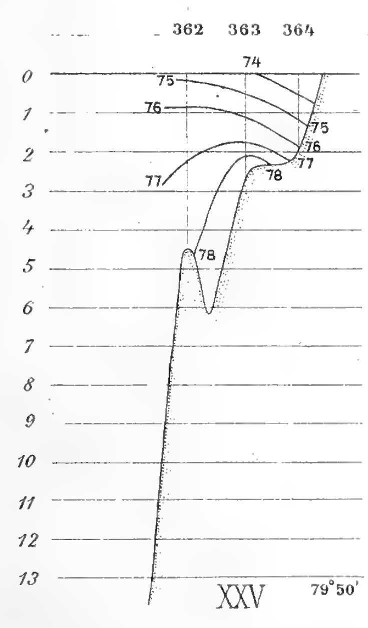

226
217
215
213
183
176
Jan Mayen
XV

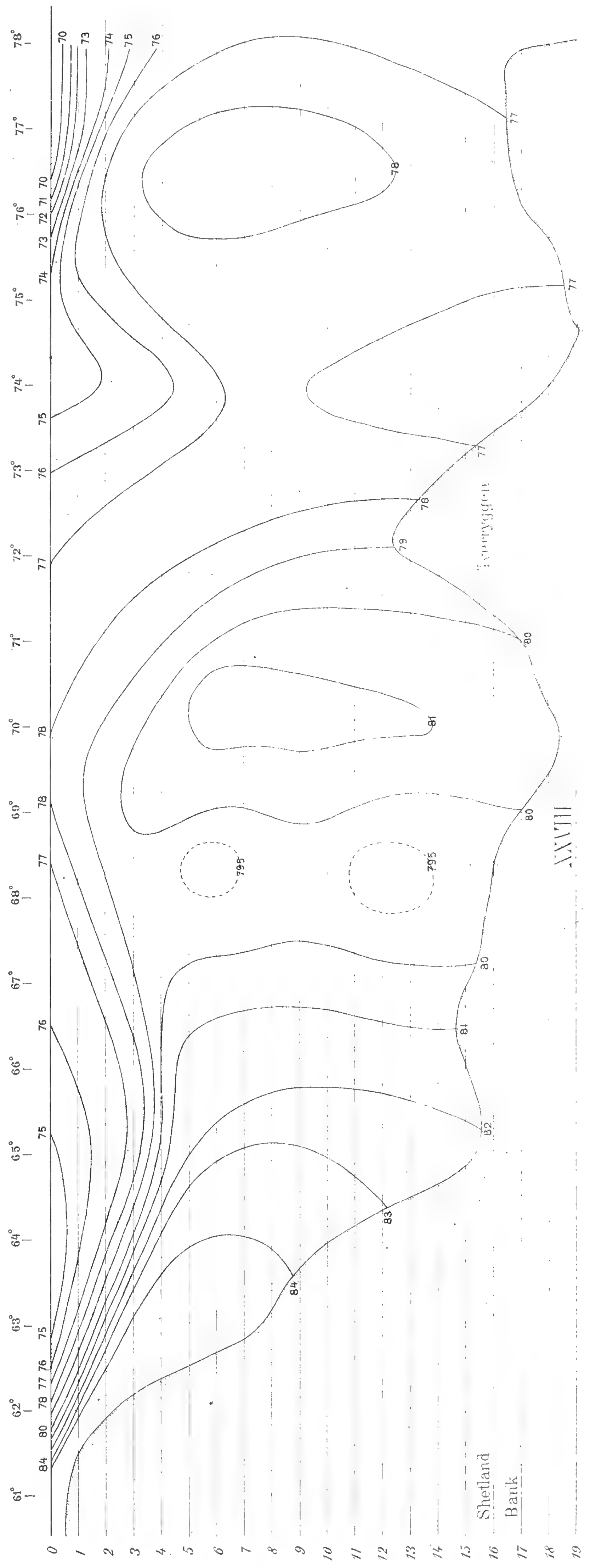

H_{III}
H_{II}
H_{I}
300
298
297
296
295
Grönland.
73°0'
XVII

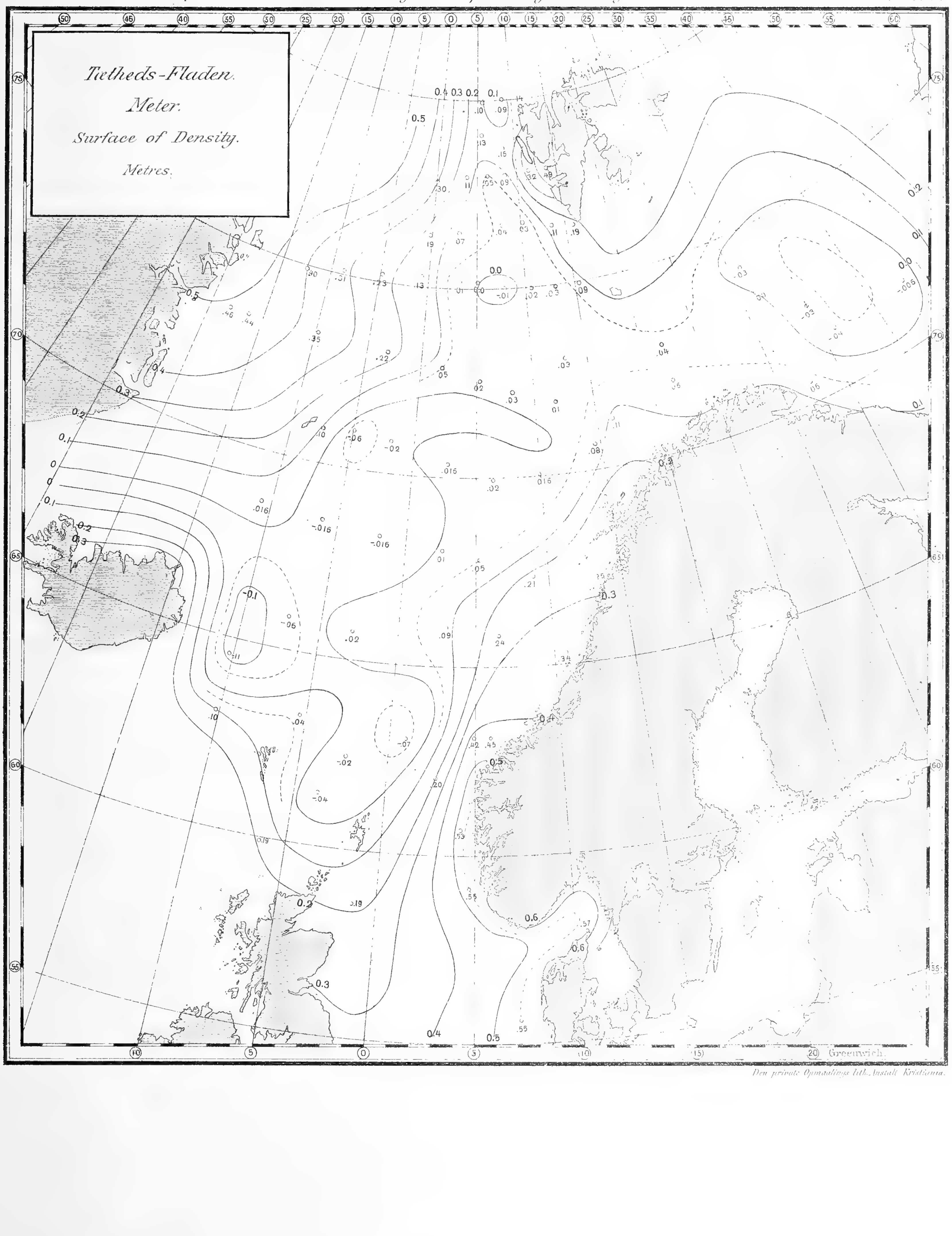

G_{III}
G_{II}
G_{I}
302
303
304
305
306
308
314
Grönland
74°30'
XIX


350 349 347 345 342 339
Sydkap
Spidsbergen
XXII

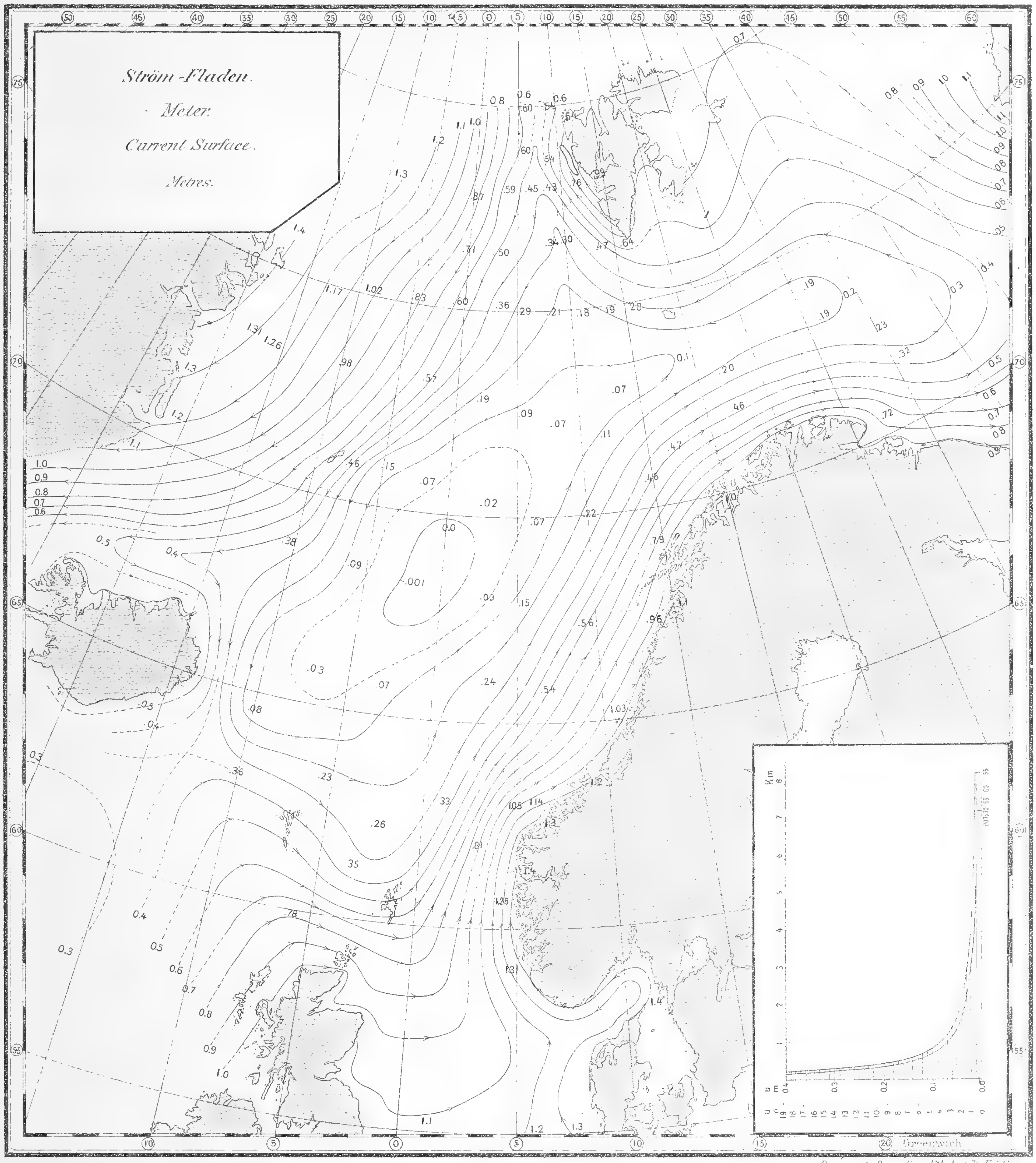

351. 352. 353-54. 355. 357. 371.
Isfjord
Ice-Sound
Spidsbergen
XXIII
78°0'


362 363 364
XXV
79°50'

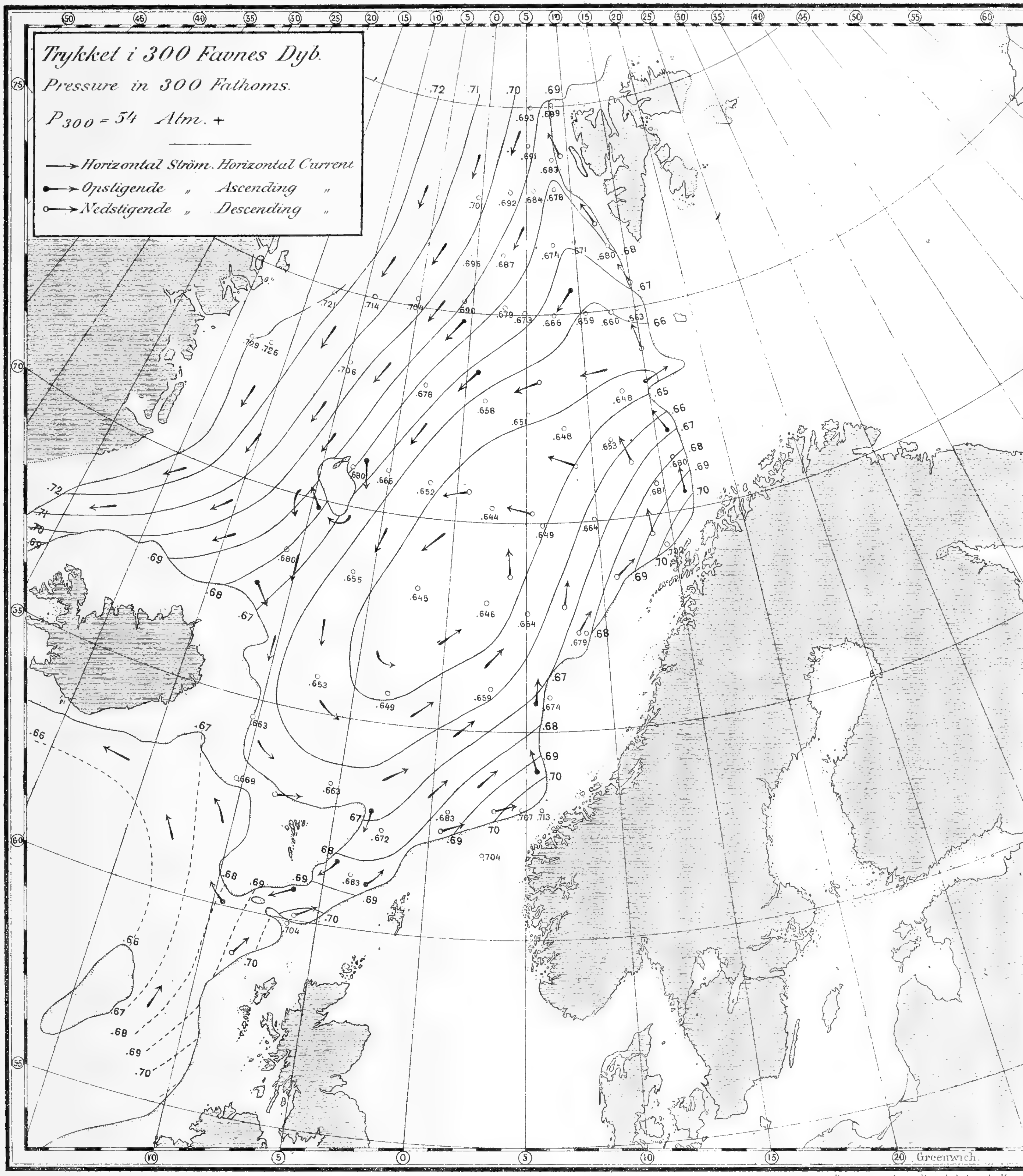

Shetland
Bank
XXVIII



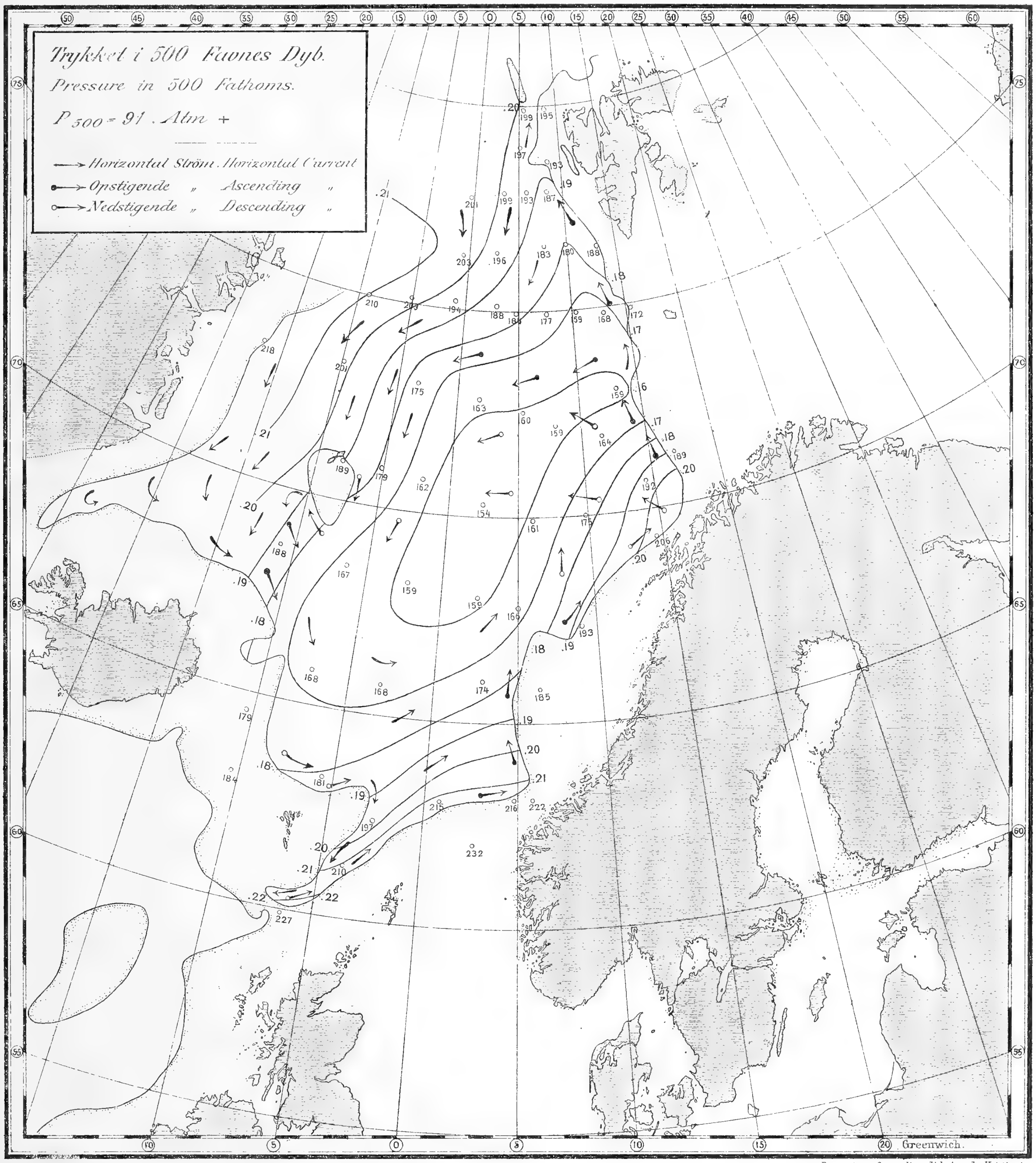
Den private Opmaalings lith. Anstalt Kristiania.



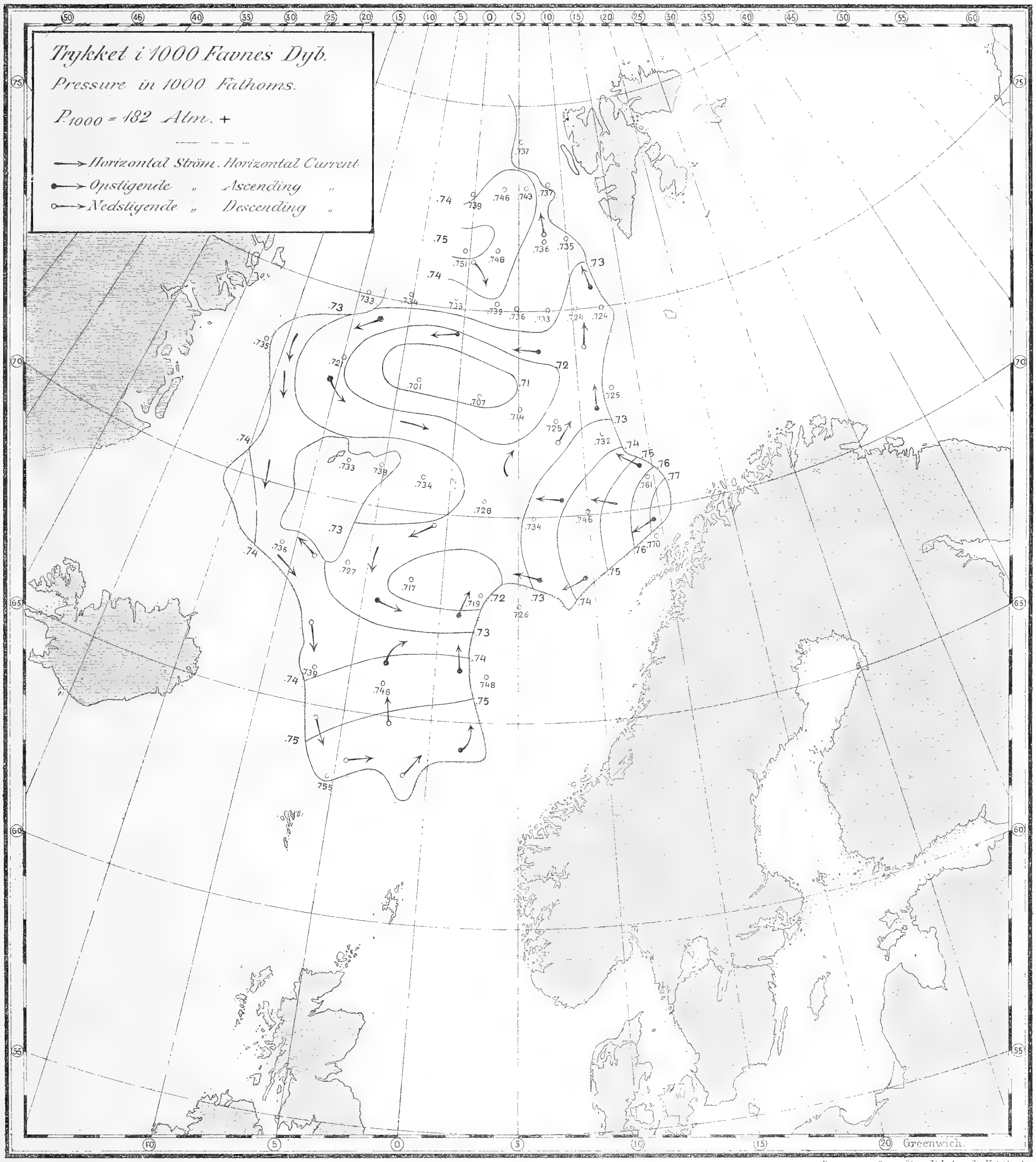
Den private Opmaalings lith. Anstalt, Kristiania.



Den private Opmaalings lith. Anstalt, Kristiania.

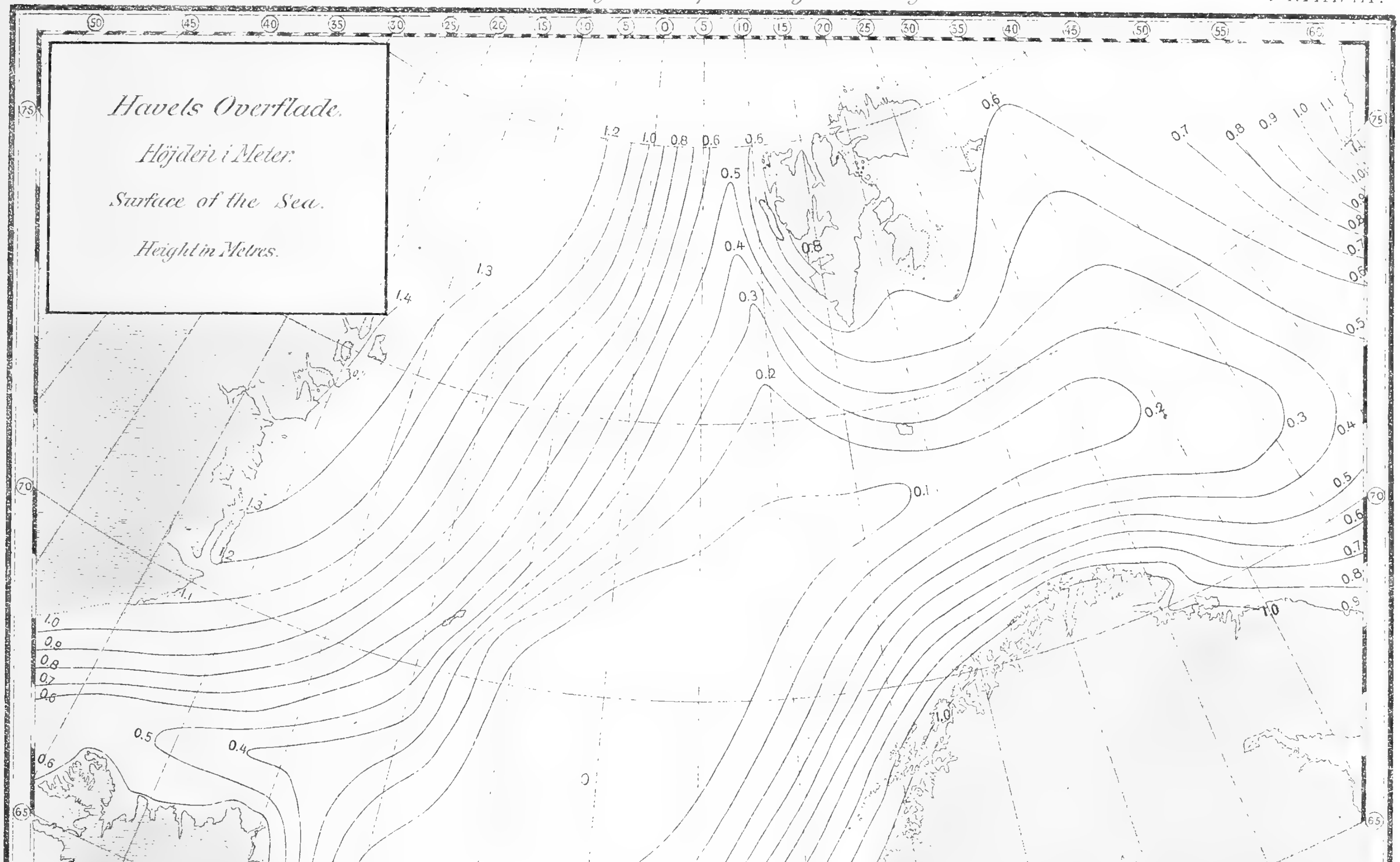


Den private Opmaalings lith. Anstalt. Kristiania.



Den private Opmaalings lith. Anstalt. Kristiania.

Den private Opmaalings lith. Inst. Kristiania.



Den private Opmaalings lith. Anstalt. Kristiania.